Attachment H

Proposal # 2001- C-203 (Office Use Only)

PSP Cover Sheet (Attach to the front of each proposal)

Proposal Title: Restoration of Delta Floodplain Terraces Through Bioengineering
Applicant Name: Habitat Assessment & Restoration Team, Inc.
Contact Name: Jeff Hart
Mailing Address: 13737 Grand Island Rd., Walnut Grove, CA 95690
Telephone: (916) 775-4021
Fax: (916) 775-4022
Email: jhart@NS.net

Amount of funding requested: $ 1,200,000

Some entities charge different costs dependent on the source of the funds. If it is different for state or federal funds list below.

State cost ____________ Federal cost ____________

Cost share partners? ___ **Yes** ✓ **No**

Identify partners and amount contributed by each ____________

Indicate the Topic for which you are applying (check only one box).

- ☐ Natural Flow Regimes
- ☐ Nonnative Invasive Species
- ☒ Channel Dynamics/Sediment Transport / Riparian
- ☐ Flood Management
- ☐ Shallow Water Tidal/ Marsh Habitat
- ☐ Contaminants
- ☐ Beyond the Riparian Corridor
- ☐ Local Watershed Stewardship
- ☐ Environmental Education
- ☐ Special Status Species Surveys and Studies
- ☐ Fishery Monitoring, Assessment and Research
- ☐ Fish Screens

What county or counties is the project located in? Sacramento

What CALFED ecozone is the project located in? See attached list and indicate number. Be as specific as possible Ecological Zone 1.1 (North Delta)

Indicate the type of applicant (check only one box):

- ☐ State agency
- ☐ Public/Non-profit joint venture
- ☐ Local government/district
- ☐ University
- ☐ Other: ____________
- ☐ Federal agency
- ☐ Non-profit
- ☐ Tribes
- ☒ Private party

Indicate the primary species which the proposal addresses (check all that apply):

- ☐ San Joaquin and East-side Delta tributaries fall-run chinook salmon
- ☐ Winter-run chinook salmon
- ☐ Spring-run chinook salmon
- ☐ Late-fall run chinook salmon
- ☐ Fall-run chinook salmon
- ☒ Delta smelt
- ☒ Longfin smelt
- ☒ Splittail
- ☐ Steelhead trout
- ☐ Green sturgeon
- ☐ Striped bass
- ☐ White Sturgeon
- ☐ All chinook species
- ☐ Waterfowl and Shorebirds
- ☒ All anadromous salmonids
- ☒ Migratory birds
- ☐ American shad
- ☐ Other listed T/E species: ______

Indicate the type of project (check only one box):

- ☐ Research/Monitoring
- ☐ Watershed Planning
- ☒ Pilot/Demo Project
- ☐ Education
- ☐ Full-scale Implementation

Is this a next-phase of an ongoing project? Yes ___ No ✓

Have you received funding from CALFED before? Yes ✓ No ___

If yes, list project title and CALFED number Project # 97-N13 / Project # 99-B106

Have you received funding from CVPIA before? Yes ___ No ✓

If yes, list CVPIA program providing funding, project title and CVPIA number (if applicable):

______

By signing below, the applicant declares the following:

- The truthfulness of all representations in their proposal;
- The individual signing the form is entitled to submit the application on behalf of the applicant (if the applicant is an entity or organization); and
- The person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section 2.4) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

Jeffrey A. Hart

Printed name of applicant

Jeffrey a. Hart

Signature of applicant

B. Executive Summary

Proposal Title: Restoration of Delta Floodplain Terraces Through Bioengineering. Requesting $1,200,000.

Applicant Information: Habitat Assessment & Restoration Team, Inc. 13737 Grand Island Road, Walnut Grove, CA 95690. Phone: (916) 775-4021. Fax: (916) 775-4022. E-Mail: jhart@ns.net

Participants and Collaborators: Reclamation Districts 563, 556, 999 and Brannan Andrus Levee Maintenance District. MBK Engineers. KSN Engineers. Davis Environmental Consulting.

Riparian habitat has been greatly diminished in the Sacramento–San Joaquin Delta. Habitat Assessment & Restoration Team, Inc. (HART) proposes to extend biotechnical bank protection/riparian restoration techniques, now underway on Georgiana Slough (Tyler Island, north Delta), to new areas. There is an urgency in this proposal, since a limited number of softbanks remain in the Delta. With no further intervention, these sites will continue to erode to the base of the levee, at which time they would be riprapped by local flood control districts or the U.S. Army Corps of Engineers. The biotechnical methods in this proposal represent an alternative, ecologically sensitive approach to bank protection.

We propose to treat sites covering approximately 10,000 linear feet on: (1) the Sacramento River on Brannan–Andrus Island, (2) Steamboat Slough on Grand Island, (3) Miner Slough (under the jurisdiction of Reclamation District 999), and (4) additional areas along Georgiana Slough. The goals of this project include: (1) protecting remaining natural embankment from further erosion; (2) reconstructing the natural berm environment either through the natural recruitment of new sediment (thereby reconstructing a new floodplain using natural means) or by the artificial addition of new soil fill; (3) developing new riparian habitat through both planting and natural recruitment that ultimately will provide wildlife habitat, especially for native fish; and (4) monitoring the effectiveness of different biotechnical bank protection methods for sediment recruitment, habitat development, and habitat use. Hypothesis testing involves comparing various factors, such as wave energy; erosion, deposition, and soil retention and mass wasting; diversity and quantity of natural recruitment; and diversity and quantity of macroinvertebrates, between control sites and treatment sites.

Scientific uncertainties being addressed include questions of the relationship between natural flow regimes, sediment transport, and riparian vegetation. It is our experience that biotechnical bank protection measures can effectively recruit sediment required for natural floodplain accretion and riparian restoration processes, thereby enhancing biological productivity.

We anticipate that our program will successfully result in improved bank protection that will reduce the risk of levee failure and enhance habitat values for aquatic macroinvertebrates and native fish species.

C. Project Description

1. Statement of Problem

a. Problem

In many areas in the Delta, riparian vegetation once reached clear across river and slough channels, forming a continuous overstory canopy from bank to bank. A variety of land uses, including early reclamation efforts, levee buiding , river channelization, construction of upstream dams, and increased recreational use of waterways, all have contributed to considerable loss of this habitat. Today, most riverbanks throughout the Delta are covered with riprap revetment; little natural softbank environment remains. Until recently, success in protecting the last remaining softbank habitats using alternative, biotechnical approaches has been limited.

Under the auspices of current CALFED Bay-Delta Program (CALFED) funding (#97-N13; #99-B106), Habitat Assessment & Restoration Team, Inc. (HART) has developed a successful pilot program in the use of alternative, biotechnical means of bank protection and simultaneous riparian habitat restoration. Given this success, we are proposing to extend these efforts to: (1) continue bank protection work on Georgiana Slough; and (2) initiate new work on the Sacramento River on Brannan–Andrus Island, Steamboat Slough on Grand Island, and Miner Slough, under the jurisdiction of Reclamation District 999 (Figure 1) . There is an urgency in this proposal, since a finite number of softbanks remain in the Delta. With no further intervention, these sites will continue to erode to the base of the levee, at which time they would be riprapped by local flood control districts or the U.S. Army Corps of Engineers (Corps) (Figures 2-3). We propose to extend the use of techniques successfully applied by HART, as well as to experiment with other combinations of approaches that have been used elsewhere.

Historically, the Delta was a comparatively a low-energy, distributary system, marked by long periods of bank stability with occasional periods of channel migration or "avulsion." The likely bank configuration therefore included a relatively stable mantle of vegetation. This Delta model contrasts with upper valley alluvial rivers that migrated constantly within their floodplains, with ongoing tearing down and building of river channels and bank landforms. Increased channelization and other land and water use changes have increased erosion in the Delta waterways compared to historical patterns/trends. Increased erosion rates also are coupled with reduced amounts of sediment transport (due to dam construction upstream), which served as the basis for natural levee and bank accretion and stability. The presence of excessively eroding banks is therefore unnatural and leads to loss of riparian habitat, including shaded riverine aquatic environments.

The underlying premise for the development of this bank protection/ riparian restoration project is that well vegetated riverbank environments, assisted with biotechnical features to deter erosion from current and wave action, provide natural bank protection and can serve to recruit and retain new sediment. Creating a more stable environment by transforming sites from an erosional to a depositional environment is necessary for the establishment and sustenance of riparian vegetation (Figure 4).

This project includes the following objectives:

- Protecting remaining natural embankment from further erosion.
- Reconstructing the natural berm environment either through the natural recruitment of new sediment (thereby reconstructing a new floodplain using natural means) or by the artificial addition of new soil fill.
- Developing new riparian habitat through both planting and natural recruitment that ultimately will provide wildlife habitat, especially for native fish.
- Monitoring the effectiveness of different biotechnical bank protection methods for sediment recruitment, habitat development, and habitat use.

The relationship of vegetation to riverbank stability has been well documented in the literature (Rosen, 1980; Schiechtl, 1980; Gray, 1989a; Coppin, 1990; Gray, 1996b although the benefits to levee maintenance and erosion control generally are not appreciated among flood control professionals. Likewise, wetland and aquatic plants exert a strong influence on the hydrodynamics of waves (Leonard, 1995; Coops, 1991; Coops, 1994; Coops, 1996a; Coops, 1996b; Chambers, 1991; Foote, 1988). Various interactive relationships between plants, hydraulic dynamics, and sediment have been described in the literature, including: (1) the role of sediment in riparian plant recruitment (McBride, 1984; Malanson, 1993); (2) plants as agents in flow resistance (Hickin, 1984; Watson, 1987); (3) the role of plants in stemming erosion, both surficial and from bank failure (Gray, 1996; Coppin, 1990; Schiechtl, 1994; Gray, 1989; Gregory, 1988; Kondolf, 1981; Smith, 1976); (4) plants as a nuclei for sedimentation (McBride, 1984; Malanson, 1993); and (5) the influence of plant architecture and vegetation characteristics on the occurrence of erosion and sedimentation (Coppin, 1990).

Research by Hart and Holm (1998) illustrated the importance of vegetation to sediment recruitment and soil conservation. Their study was designed to determine how various configurations of plants and fabric affect erosional and depositional processes on a revetment site along the Lower American River in Sacramento, California. The experimental methods included eight treatments, each measuring 2 x 2 meters, that used different combinations of soil, annual grasses, sedges, coir fabric, and an inner fabric cloth. Each treatment was replicated seven times, and the treatments were randomized along a 112-meter section of river embankment. The entire site flooded during 1996-1997 for more than 3 months. After winter floods subsided, the study plots were studied to determine relative deposition and erosion by measuring the amount of rock surface exposed within each plot compared to the before-flood conditions. The treatments ranged from 84% rock exposed for the control (soil alone) to 1% for the full treatment of soil, inner blanket, coir, annuals, and sedge. The results of our experiment highlight the importance of herbaceous plants and landscape fabric in providing the amount and quality of roughness necessary to protect revetment sites from scour and to encourage sediment deposition—conditions necessary for successful riverine habitat restoration. The results of the study by Hart and Holm (1999) and other studies are being used as the basis for the design of the planting and bioengineering elements of this project, as well as design concepts from standard texts (Schiechtl, 1980; Gray, 1989a; Coppin, 1990; Gray, 1996b; Schiechtl, 1997; Allen, 1997).

Through ongoing CALFED funding, more recent work on Georgiana Slough has been equally enlightening on the relationship between the use of biotechnical features, bank protection, and sediment recruitment (Figures 5-8). Various methods have been used to successfully reconstruct a miniature "floodplain" at the site of the original vegetated berm through the recruitment of up to 2 feet of sediment during a single winter. Native sedges and rushes have been planted on the newly constructed floodplain; ultimately, riparian trees will be will be installed. Using these methods, the restoration of nearbank riparian vegetation and function is promising.

The approach of this project is the application of biotechnical or bioengineering techniques and materials to provide structural elements, including organic materials and occasionally rock features, that provide temporary bank protection until the vegetation matures sufficiently to effectively protect the river bank environment. Bioengineering structures can serve many functions: wave and current energy reducers, surface or soil protection features, sediment trapping elements, ballasted or anchored materials that resist being swept away, and ground stabilization structures that protect the bank from mass failure. A particular structural element often may serve multiple functions. Ultimately, the plants installed with these features will mature and provide many of the same protective functions. The biotechnical features may be classified as follows:

- Breakwater structures.
- Soil protection techniques.
- Sediment recruitment and retention techniques.
- Plant-anchoring or weighting techniques.
- Ground stabilization techniques.

These features are discussed below.

<u>Breakwater Structures</u>. Several breakwater structures were considered for the ongoing projects (#97-N13; #99-B106), including floating logs, brush boxes or branch box breakwaters or brushwood fascines, wooden platforms, sand-filled geotubes, sandbags, peaked stone dikes or rock groins, coir geotextile rolls, plastic sheetpiles, and trees as revetment. The method that HART has successfully deployed is a branch box breakwater structure. This structure is constructed from long poles inserted vertically into the embankment, with

bundles of small dead branches (called fascines) packed between the poles and secured with twine or cable. To attract sediment, the fascines may be enveloped in coconut fabric or similar material to further slow current and wave energy (Figures 5-8). Brush boxes or brushwood fascines have been used in Europe (Boumans, 1997; Ostendorp, 1995), the Louisiana delta (Boumans, 1997; Good, 1993), and locally on Georgiana Slough—all with positive results. Boumans (1997) reported wave energy reductions of 50% across monitored fences and elevation increases up to 3.3 centimeters per year (cm/year).

Other possible breakwater structures may be fashioned. Stone or rock may be covered within nylon or wire (gabion) material to function as a breakwater. Geotextile tubes, constructed of synthetic material, may be filled with sand and placed along the shoreline to deflect waves. In Germany, coir geotextile rolls, rock berms, and rock rolls containing vegetative plantings are installed shoreward of the breakwater structures . In Michigan, Fuller (1997) reported the use of coir geotextile rolls, placed between the shoreline and a row of rocks, that function to dampen waves. Trees and logs can be floated into place, secured to each other and the substrate with cable. With time, the logs sink to the bottom, thereby serving a breakwater function. Geotextile bags and tubes have been used as breakwaters. Since they must be hydraulically filled with sand places at the locations where they are to be constructed, their use is limited to areas where the appropriate substrate is found. In the Delta, this method has proven expensive.

Plants also can be used to dampen the energy of waves. The amount of dampening that occurs is related to the nature and the width of the vegetation. A study in the Chesapeake Bay determined that more than 50% of the energy associated with waves was dissipated by 2.5 meters of marsh habitat (Knutson, 1990; Knutson, 1982). Stem density and the size of the stems also influence wave energy. Greater numbers of small-diameter plants are more effective than fewer, larger diameter materials. Rosen (1980) found that fringe marshes reduced erosion rates by 20-50%, depending on the particular geomorphic setting. However, not all physical environments are suitable for the use of plants to dampen wave energies. In extremely exposed environments, emergent macrophytes may be limited. Hall (1975) reported the vegetative protection of shorelines to be limited due to high wave energy, winter icing, and fluctuating water levels.

<u>Soil Protection Techniques</u>. Various techniques are used to protect the ground surface from the erosive energies of water current, waves, and wind. The eventual establishment of a living ground cover, such as a dense sward or turf of graminoid plants, will protect the ground surface. Various kinds of inert, organic or synthetic materials are available for short-term protection until vegetation becomes thoroughly established. These materials include types of rolled erosion control blankets (for example, coir, jute, wood excelsior, straw, and coconut fibre [coir]), brush matting or mattresses, and synthetic products. Organic materials have the advantage of eventually decaying, whereas synthetic materials may remain in place for decades or more.

Sediment Recruitment and Retention Techniques. Increased deposition of sediment occurs with the reduction of wave energy and currents, assuming that suitable sediment loads exist. Gleason (1979) documented a positive relationship of sedimentation with increased stem density. The work by Hart and Holm (1998) similarly documented the positive relationship between roughness at a microscale and deposition. Materials must be sufficiently dense to slow current velocities in order to adequately recruit sediment and simultaneously prevent these materials from washing away. Materials that effectively recruit sediment include coir biologs, coir mattresses, log brush barriers (Figure 9) brush boxes, and other dense matted or branched materials. With sufficient sediment established in these structures, plants then can become established. Boumans,(1997) reported surface elevation increases up to 3.3 cm/year using silt fences made from piles and Christmas trees. Boumans concluded that silt fences will produce land more quickly if they are placed in the shallowest water available. On the Kenilworth Marsh in the District of Columbia, Bowers (1995) used brush bundles as sediment containment enclosures for dredged materials. Bowers found that the structures were too porous to retain sediment, and that straw bales were more efficient. Sediment recruitment and retention structures should be designed to permit sediment-laden waters to pass through the outer perimeter layers and to deposit in the interior zones. This can be accomplished by locating more porous structures outboard and placing more dense structures in interior areas.

Plant-Anchoring or Weighting Techniques. Plants are naturally anchored by the presence of extensive root systems. However, establishing plants in high-energy wave environments may require the imaginative use of anchored planting techniques in the early phases of plant establishment. Many of the commonly used bioengineering products, such as mats and rolls or live willow wattling, are anchored to the shore with stakes, rebar, or anchoring pins. Other specialized methods include planting structures with anchor rods, plants fixed to concrete rings and cast onto the shore bottom, and roots of aquatic plants fixed to packing wire inserted into the soil. Fonseca (1994) deployed three different planting methods: (1) fixing plants to the bottom with large staples (U-shaped metal rods, approximately 2 millimeters in diameter, with the leg of each rod being about 20 cm long; (2) the coring method (10-cm-diameter PVC core tubes used to extract sediment from the shorebottom, after which plugged plants are installed in the hole; and (3) the plug/peatpot method (a 7.6- x 7.6-cm Jiffy Pot made of compressed peat that is installed with a sod plugger).

Another strategy is the placement of heavily weighted planting materials with a soil medium resistant to erosion. These materials must be sufficiently heavy to prevent being washed away, and their soil structure must resist erosion. HART's ballast buckets are made of an organic, biodegradable bucket, filled with a clayey loam and grown with plants capable of forming dense roots and living through long periods of inundation (Figures 5, 6, 7). Logs and rootwads can be attached to the shore with earth anchors or duckbill structures. These consist of cable attached to the midsection of a flange of metal, which is driven into the embankment. As the cable tightens, the metal flange is pulled perpendicular to the embankment, thus resisting being pulled out.

Ground Stabilization Techniques. These methods reduce the mechanical forces active in the deeper soil mantle. Deeper structures or roots can be very effective in stabilizing the soil, thereby reducing mass slippage. Bioengineering techniques include the use of live cuttings, earth-filled brush works, branch packing, brush layering, wattle fence and wattles (or fascines), layer construction, vegetated geogrids, rock rolls, lunkers, dormant posts, vegetated live crib walls, biologs, root wads, live slope grating, gabion walls, bank crib with cover log, and log revetments (Figures 10-16). In streambank environments, these structures often are placed at the base of the slope for toe protection.

To date, HART has successfully applied many elements of the structures described above, including brush boxes, coir biologs, ballast buckets, and brush bundles. These elements, as well as combinations of structures described above (see Figures 5-16), likely will be deployed in the proposed projects.

1. Conceptual Model

Erosion/Degradation Model. Bank erosion processes include the following sequence of events. Initially, a thick stand of riparian vegetation serves a function in bank protection. With continued erosional effect of waves and current affecting the shoreline environment, an opening or break eventually is created in the vegetative armor. The presence of shoreline irregularities, including small breaks or indentations, provides a focal point for the concentration of wave energy. Thus begins the formation of the semi-circular embayments or "scallops" characteristic of areas experiencing wave-induced shoreline erosion (Figures 2, 3). With time, wave energies enlarge the size of the scallop well within the berm, eventually extending to the levee itself. This process is compounded by bank failure processes in which the oversteepened bank slopes fail after winter floodflows. With erosion occurring dangerously close to the levee toe, reclamation districts and flood control agencies are compelled to place riprap along the base of the levees for protection (Figures 2-3). Once this occurs, the softbank is irretrievably lost, along with the habitat conditions (Figures 9-16).

Deposition/Aggradation Model. HART has been able to reverse the degradational process described above and create a depositional model in its place. Techniques involve the construction of a composite series of structures such as brush boxes, brush bundles, coir biologs, and ballast bucket plantings. These structures dampen wave energy during the summer boating season, and then function to trap sediment during the winter. As sediment accumulates during the winter flood season and then is protected during the spring and summer season, a miniature floodplain builds up that can be reclaimed for riparian restoration (Figures 4). The techniques already developed by HART will be expanded upon (see Figures 9-16) in order to accommodate a greater diversity of erosional situations.

b. Hypotheses Being Tested

The following hypotheses will be tested with monitoring data from a formal experiment.

1. Wave Energy: During a 10-week period in the middle of the low-flow season, average cumulative wave energy per scallop as measured by wake gauges will be lower in the treatment sites than in the do-nothing control sites.

2. Erosion, Deposition, Soil Retention. For the first 2 years, by the end of the low-flow season, the average of net erosion/deposition/soil retention within each year will be at least 3 cm greater in the treatment sites than in the do-nothing control sites.

3. Mass Wasting. By the end of the high-flow storm season each year, average centimeters of horizontal bank movement through mass wasting will be lower in the treatment sites than in the do-nothing control sites.

4. Diversity of Natural Recruitment. The mean number of native plant species that established through natural recruitment will differ significantly between the treatment sites and the do-nothing control sites.

5. Quantity of Natural Plant Recruitment. The cover of native plants that established through natural recruitment will differ by at least 5 % between the brush fence sites and the do-nothing control sites.

6. Diversity and Quantity of Macroinvertebrates. Throughout each low-flow season, the average species richness and biomass of macroinvertebrates will differ significantly between the treatment sites and the do-nothing control sites.

The restored areas are small in comparison to the expansive continuity of the environments used by salmonids and other fish during their life history cycle. The determination of the statistical significance of fisheries benefits is nearly impossible in the context of the background "noise" of the factors affecting fish populations in the Delta and elsewhere. Therefore, scientific monitoring of fish populations will not be attempted for this project, although informal observations will be recorded. However, the presence of macroinvertebrates, considered to be useful surrogates for fish habitat quality, will be scientifically monitored, as their relatively sedentary, locally based life history characteristics will provide a more reliable source of data.

The implementation of this project will provide information relating to several scientific uncertainies identified in CALFED's Proposal Solicitation Package (PSP) .

The funding of this project addresses several of the scientific uncertainties mentioned in the Ecosystem Restoration Program (ERP) Strategic Plan:

- Natural Flow Regimes, Sediment Transport, Channel Dynamics, and Riparian Vegetation. Altered hydrodynamic processes have changed sediment pulses necessary for restoration. The implementation of this project, along with the monitoring program as outlined above, will assist in determining the availability of sediment for restoration of floodplain landforms. The presence of riparian vegetation and biotechnical bank protection measures serves to trap sediment and to improve water quality. Sediment transport studies, based in the disciplines of hydrology, generally do not identify plants and sediment interactions. The presence of sediment is considered an important requirement for the restoration of many kinds of habitats. It is well known that sediment provides numerous benefits to riparian ecosystems. While the system-wide depravation of natural sediment gives pause for restoration possibilities, the capacity of dense vegetation to recruit sediment is greatly under-appreciated. Previous studies by Hart and Holmes (1999) and ongoing CALFED restoration efforts on Georgiana Slough show promising possibilities for recruitment of sediment at targeted locations. The expansion of these methods to other tributaries in the Delta will greatly enhance the broader applicability of this approach to other areas in the Delta.

- Decline in Productivity. The loss of softbank riverine environments to rock revetment would appear to be associated with a/the general decline in Delta productivity. Arresting erosion and restoring the biological function to nearshore riparian environments will assist in increasing biological productivity. Specifically, monitoring the macroinvertebrate response to these restoration efforts (and by extension, the response of fish) will document this favorable trend.

Data collecting methods include the use of erosion pins placed at randomly determined locations within treatment and control sites. Using these pins as points of pretreatment land surface elevations, data collected will determine the amount of loss, retention, and/or gain of sediment at specific locations. Percent survival of installed plants and vegetation recruitment and growth will be determined using standard plant ecological methods. An analysis of variance (ANOVA) will be used to determine significance differences for hypotheses being tested.

c. Adaptive Management

As with currently funded CALFED projects, HART will deploy adaptive management strategies. With the projects already in process, we have altered installation techniques, the nature and size of the materials used, and the timing of installation. These new projects will benefit from these lessons already learned.

Since we are expanding efforts into some new tributaries (e.g., Sacramento River, Steamboat Slough, and Miner Slough) with potentially new conditions, we will need to adapt, expand, and/or alter our current palette of materials and methods. For example, wave and current energies on the Sacramento River are potentially greater than on the other tributaries. Accordingly, we propose to use more resistant biotechnical materials. Some of the embankments are sufficiently steep that entirely different methods, such as crib walls and gabion structures (Figures 15-16), may need to be used. Each of these new methods will require adaptive management at the installation phase of the project. "Pilot" installations of materials initially will test implementation timing, construction techniques, and function. As confidence grows with each method, materials will be installed at the project level. Adaptive management also will come into play on a longer term basis as the knowledge of the successes and failures of the various deployed techniques can be used to direct future restoration projects in the Delta.

2. Proposed Scope of Work

a. Location and/or Geographic Boundaries of the Project

This project will involve bank protection locations on Georgiana Slough, Tyler Island and Brannan–Andrus Island; the Sacramento River, Brannan–Andrus Island; Steamboat Slough, Grand Island; and Miner Slough (under the jurisdiction of Reclamation District 999). All projects are in the Delta Ecozone. Centroids are: (1) Sacramento River, between Isleton and Walnut Grove, Isleton Quad: 38° 12'30"/121° 33' ; (2) Georgiana Slough: Isleton Quad: 38° 12'30"/121° 32'; (3) Steamboat Slough, Rio Vista Quad: 38° 11'/121o 138'. Miner Slough, Courtland Quad: 38° 17' 30"/121° 37' 30". (See Figure 1)

b. Approach

Approximately 9,500 linear feet of eroded scallops have been identified along Georgiana Slough (3,200 linear feet), Steamboat Slough (1,000 linear feet), Miner Slough (300 feet), and the Sacramento River (5,000 linear feet). The approach will involve: (1) mapping in detail the erosion sites to be treated, (2) developing a restoration/monitoring plan, (3) applying for permits, (4) obtaining peer review of the plan and revising the plan as needed, (5) implementing the project, (6) monitoring the project, and (7) applying the principles of adaptive management based on monitoring results.

This project includes:

1. Installing biotechnical bank protection that will both protect the banks from erosion and trap new sediment or retain sediment fill.

2. Planting riparian plant species for habitat development and additional erosion control.

The methods used will be based on the successes and/or failures of previous treatments (adaptive management) and new design concepts. To ensure that a diversity of design concepts is considered, HART will contract with other bioengineering specialists to assist in augmenting a greater palette of methods. This process will provide a means of peer review of current designs and, if needed, new ideas. Some of these new techniques may include crib walls, log revetment, gabion structures, and lunkers in steep bank areas and other breakwater structures to dampen wave energies affecting bank stability. Most of these methods are easily installed using hand labor, and many of the materials are collected from Delta orchards. These treatments will be generously planted with sedges, and wood plants such as alders, willows, box elder, ash, cottonwoods, and oaks—all collected from local genetic stock. The design of these techniques has been based on geomorphic and hydraulic analyses and experience from the use of these materials in similar environments.

c. Monitoring and Assessment Plans

The research/monitoring program will include testing a variety of scientific hypotheses and general areas of interest, such as erosion/deposition relationships, boat-wake energies, instream shade, richness and biomass of aquatic macroinvertebrates, and plant survival and cover, between control and treatment sites. The completed restoration/monitoring plan will include the following chapter topics: (1) project goals and objectives; (2) hydraulic, geomorphic, and biological description of the sites; (3) statement of hypotheses; (4) sampling or censusing designs and methods for depositional/erosional patterns and aquatic macroinvertebrate use and for plant habitat establishment patterns; (5) data management and quality control; (6) data evaluation protocols; and (7) procedures for utilizing monitoring results in adaptive management of the project.

d. Data Handling and Storage

Data will be captured and stored in various formats, including GIS data (ArcView), photo monitoring (JPEG or other format), tabular format (Excel), and relational database (Access). The data will be analyzed using ANOVA statistical methods and will be presented in written, chart, and pictoral formats.In addition to CALFED quarterly reports, information will be distributed through publications in referred journals, popular magazines, and seminars and visually through web site development. Additional information, including onsite tours, will be provided upon request.

e. **Work Schedule**

The work is divided into several distinct, but somewhat overlapping phases that will occur over a 3-year period: (1) plan development and permitting (to be completed by spring 2001), (2) project construction (to be completed in summer and fall 2001-2002), and (3) project monitoring and adaptive management (at least through 2002-2003).

f. **Feasibility**

The practical feasibility of the approach outlined above has already been demonstrated through previous CALFED funding (#97-N13; #99-B106; see Figures 5-8). HART intends to extend the techniques already successfully used and to test a broader arsenal of approaches.

The several Reclamation Districts affected all have given their support for the project. To date, project permitting has not proved to be insurmountable. From a planning and regulatory perspective, reconstructing the original bank and planting riparian vegetation, will not negatively affect hydraulic conveyance, and should not raise concerns from local Reclamation Districts or the State Reclamation Board. Virtually no land transformations requiring engineering are proposed at this stage; hence, these activities would not appear controversial to potentially affected parties. Little regulatory planning is entailed. A Nationwide 13 permit, with input from the State Water Resources Control Board, California Department of Fish and Game, and National Marine Fisheries Service, has been expeditiously approved for similar work. The planting of trees and the possible placement of soil fill material will require permitting from the State Reclamation Board.

D. Applicability to CALFED ERP Goals and Implementation Plan and CVPIA Priorities

1. ERP Goals and CVPIA Priorities

This project supports several of the CALFED Program objectives in improving ecosystem quality, water quality, and levee system integrity. The project also supports several goals of the ERP in improving aquatic and terrestrial habitats. Specifically, implementing this project will aid (as numbered in CALFED's 2001 PSP): **Goal 1**, in the recovery of at-risk species in the Delta; **Goal 2**, ecosystem processes and biotic communities; **Goal 4**, habitats; and **Goal 6**, sediment and water quality.

At-risk fish species include split tail, delta smelt, and salmonids. Studies have shown that shaded riverine aquatic habitat provides the following essential elements for outmigrating fish: cover, resting areas from hydraulic turbulence, escape from predators, and a source of macroinvertebrates as food. The monitoring and implementation aspects of this project will aid in the understanding of ecosystem processes in relationship to habitat restoration. In particular, the capacity of certain sites to recruit sediment and initiate successional processes is crucial to ecosystem rehabilitation andincreased productivity, especially of aquatic species.

2. **Relationship to Other Ecosystem Restoration Projects**

This project builds on several other current projects in the Delta and broadens the experimental design already underway for several projects in the Delta, such as #97-N13 and #99-B106 on Georgiana Slough and the North Fork of the Mokelumne River, AB 360 on the North Fork of the Mokelumne River, and a Corps demonstration project on Steamboat Slough.

3. **Requests for Next-Phase Funding**

Not applicable.

4. **Previous Recipients of CALFED or CVPIA Funding**

Two other CALFED projects have been awarded to HART: #97-N13 and #99-B106.

5. **System-Wide Ecosystem Benefits**

The implementation of this project will result in the enhancement of nearly 10,000 linear feet of critical shoreline riparian environments, habitat that will benefit the principal native fish species that either migrate through or reside in the Delta.

E. Qualifications

HART. This project will be delivered by the Habitat Assessment & Restoration Team, Inc. (HART), located near Walnut Grove, CA. HART specializes in natural resource surveys and habitat analyses, restoration design, propagation of native wetland plants, and restoration implementation. Located along Steamboat Slough on Grand Island (in the Delta), H.A.R.T. Inc.'s 10-acre facility includes a plant nursery stocked with native wetland and riparian plants, a potting barn and storage and tool sheds, greenhouse, several vehicles, office facilities including four computer work stations with GIS and graphics capabilities, and considerable room for growth. Jeffrey A. Hart, Ph.D., will serve as overall project manager. Dr. Hart has had considerable success in designing and implementing restoration projects (e.g., Stone Lakes National Wildlife Refuge, Twitchell Island, Decker Island), bioengineering projects (e.g., Dry Creek, Lower American River, North Fork of the Mokelumne River, Georgiana Slough, Steamboat Slough), and resource studies (e.g., Cosumnes River and Lower American River). His clients include mostly government agencies and non-profit companies such as the Sacramento Area Flood Control Agency, California Department of Water Resources, Turlock Irrigation District, Sacramento County Water Resources Division, Ducks Unlimited, and The Nature Conservancy. HART has successfully completed restoration contracts with Ducks Unlimited (contact Jim Well, phone 916/852-2000). Since moving to Grand Island in July 1998, HART has successfully established a native plant nursery where considerable quantities of native plants are already under propagation. Many of the tasks for the project will be performed by Jeff Hart and HART employees. Other tasks will be performed by the following subcontractors.

Gilbert Cosio. MBK Engineers. Mr. Cosio is a principal engineer and vice president of Murray, Burns & Kienlen. He is a registered professional engineer (civil). He began his 18-year career at Bechtel Power Corporation as a civil/structural design engineer in charge of concrete and steel design, and has been an employee of Murray, Burns & Kienlen since 1984 when he began working in the Delta. Mr. Cosio has experience in flood control, hydrology, hydraulics, water resource planning, drainage water supply, surveying, and levee maintenance. Mr. Cosio is currently principal-in-charge of all Delta levee reclamation district work for Murray, Burns & Kienlen. Mr. Cosio coordinates levee inspections, levee maintenance and rehabilitation projects, competitive bid plans and specification preparation, and contract administration for Delta reclamation districts. He also oversees maintenance planning, funding application and claims, regulatory coordination, environmental assessments, CEQA documentation, and reports and presentations to respective reclamation district boards of trustees.

Kjeldsen, Sinnock & Neudeck, Inc. (KSN). KSN will provide survey, mapping, and planning functions. This firm is a full service civil engineering and land surveying firm specializing in the surveying, mapping, planning, design and construction of municipal, public works and water resources related projects. The firm currently serves as consultants to over thirty communities, special districts, and local public agencies in the San Joaquin County and foothill areas. The firm presently maintains a highly qualified staff of over twenty, which includes civil engineers, land surveyors, a landscape architect, engineering and CADD technicians, field inspectors and additional administrative support staff.

Robert Miller & Associates and DCI Engineering. These two engineering firms represent Brannan – Andrus Island.

Davis Environmental Consulting. Davis Environmental Consulting provides professional consulting services in biological resources regulatory compliance, habitat restoration and mitigation planning, performance monitoring, and construction oversight. Davis Environmental Consulting has particular expertise in handling wetland regulatory compliance issues and threatened and endangered species issues. Davis Environmental Consulting will be assisting H.A.R.T., Inc. with regulatory agency coordination and consultation; producing permit application packages; and coordinating wetland delineations and other biological studies for wetland and endangered species regulatory compliance. Ellyn Miller Davis, principal of Davis Environmental Consutling, has in-depth experience in and knowledge of natural resources planning and regulatory compliance. Her 14 years experience as an environmental consultant has provided her with a solid working knowledge of environmental resource laws and regulations including Sections 404 and 401 of the federal Clean Water Act, Section 10 of the Rivers and Harbors Act, National Environmental Policy Act, Fish and Wildlife Coordination Act, Endangered Species Act, California Environmental Quality Act, and Section 1600 et seq. of the California Fish and Game Code

F. Cost

1. Budget

Table I gives a cost breakdown for the budget. The total cost for the project is $1.2 million for 9,500 linear feet of biotechnical bank protection/habitat restoration. As can be seen from the task breakdown, this includes 1) planning and permitting; 2) restoration and monitoring plan, plant progagation, materials, restoration implementation, monitoring, and project management. Most of the work will be done by HART employees, with outside consultants supplying speciality services such as planning and permitting, biological monitoring (macroinvertebrates) and engineering services. Overhead is included in the project management component, and includes time spent in contract administration as well as normal project oversight duties.

2. Cost-Sharing

Not applicable.

G. Local Involvement

This project is fully supported by the local reclamation districts and land owners.

H. Compliance with Standard Terms and Conditions

HART can comply with all terms and conditions described in Attachment D of the PSP (Terms and Conditions for State Proposition 204 Funds).

I. Literature Cited

Allen, H. H. and J. R. Leach (1997). Bioengineering for Streambank Erosion Control, US Army Corps of Engineers.

Boumans, R. M. J., J. W. Day, et al. (1997). "The effect of intertidal sediment fences on wetland surface elevation, wave energy and vegetation establishment in two Louisiana coastal marshes." Ecological Engineering **9**: 37-50.

Bowers, J. K. (1995). "Innovations in tidal marsh restoration." Restoration & Management Notes **13**(2): 155-161.

Chambers, P. A., E. E. Prepas, et al. (1991). "Current velocity and effect on aquatic macrophytes in flowering waters." Ecological Applications **13**: 249-257.

Coops, H., R. Boeters, et al. (1991). "Direct and indirect effects of wave attack on helophytes." Aquatic Botany **41**: 333-352.

Coops, H., N. Geilen, et al. (1994a). "Distribution and growth of the helophyte species *Phragmites australis* and *Scirpus lacustris* in relation to wave exposure." Aquatic Botany **48**: 273-284.

Coops, H., N. Geilen, et al. (1996b). "Interactions between waves, bank erosion and emergent vegetation: an experimental study in a wave tank." Aquatic Botany **53**: 187-198.

Coops, H. and G. V. d. Velde (1996). "Effects of waves on helophyte stands: mechanical characteristics of stems of *Phragmites australis* and *Scirpus lacustris*." Aquatic Botany **53**: 175-185.

Coppin, N. J. and I. G. Richards, Eds. (1990). Use of Vegetation in Civil Engineering. London, Butterworths.

Fonseca, M. S., W. J. Kenworthy, et al. (1994). "Seagrass planting in the southeastern United States: methods for accelerating habitat development." Restoration Ecology **2**(3): 198-212.

Foote, A. L. and J. A. Kadlec (1988). "Effects of wave energy on plant establishment in shallow lacustrine wetlands." Journal of Freshwater Ecology **4**(4): 523-532.

Gleason, M. C., D. A. Elmer, et al. (1979). "Effects of stem density upon sediment retention by salt marsh cordgrass, *Spartina alterniflora* Louisel." Estuaries, Journal of the Esturarine Research Federation **2**(4): 271-273.

Good, B. (1993). "Louisiana's Wetlands." Restoration & Management Notes **11**(2): 125-133.

Gray, D. H. and A. T. Leiser (1989). Biotechnical slope protection and erosion control. Malabar, Florida, Krieger Publishing Company.

Gray, D. H. and A. MacDonald (1989). The role of vegetation in River Bank Erosion. Symposium on River Bank Erosionf, ASCE National Conference on Hydraulic Engineering, New Orleans, Louisiana.

Gray, D. H. and R. B. Sotir (1996). Biotechnical and soil bioengineering slope stabilization; a practical guide for erosion control.

Gregory, S. V., G. A. Lamberti, et al. (1988). Influence of valley floor landforms on stream ecosystems. Proceedings of the California Riparian Systems Conference: protection, management, and restoration for the 1990's; 1988 September 22-24, Davis, CA, Gen. Tech. Rep. PSW-110. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture.

Hall, V. L. and J. D. Ludwig (1975). Evaluation of potential use of vegetation for erosion abatement along the Great Lakes shoreline.

Hickin, E. J. (1984). "Vegetation and river channel dynamics." Canadian Geographer **28**(2): 11-126.
Knutson, P. L., R. A. Brochu, et al. (1982). "Wave damping in Spartina alterniflora marshes." Wetlands **2**: 87-104.
Leonard, L. A. and M. E. Luther (1995). "Flow hydrodynamics in tidal marsh canopies." Limnological Oceanography **48**(8): 1474-1484.
Malanson, G. P. (1993). Riparian Landscapes, Cambridge University Press.
McBride, J. R. and J. Strahan (1984). "Establishment and survival of woody riparian species on gravel bars of an intermittent stream." American Midland Naturalist **112**: 235-245.
Ostendorp, W., C. Iseli, et al. (1995). "Lake shore deterioration, reed management and bank restoration in some Central European lakes." Ecological Engineering **5**: 51-75.
Schiechtl, H. (1980). Bioengineering for land reclamation and conservation, The University of Alberta Press.
Schiechtl, H. M. and R. Stern (1997). Water Bioengineering Techniques for Watercourse, Bank and Shoreline Protection. Oxford, Blackwell Science.
Smith, D. (1976). "Effect of vegetation on lateral migration of anastomosed channels of a glacial meltwater river." Geological Society American Bulletin **87**: 857-860.

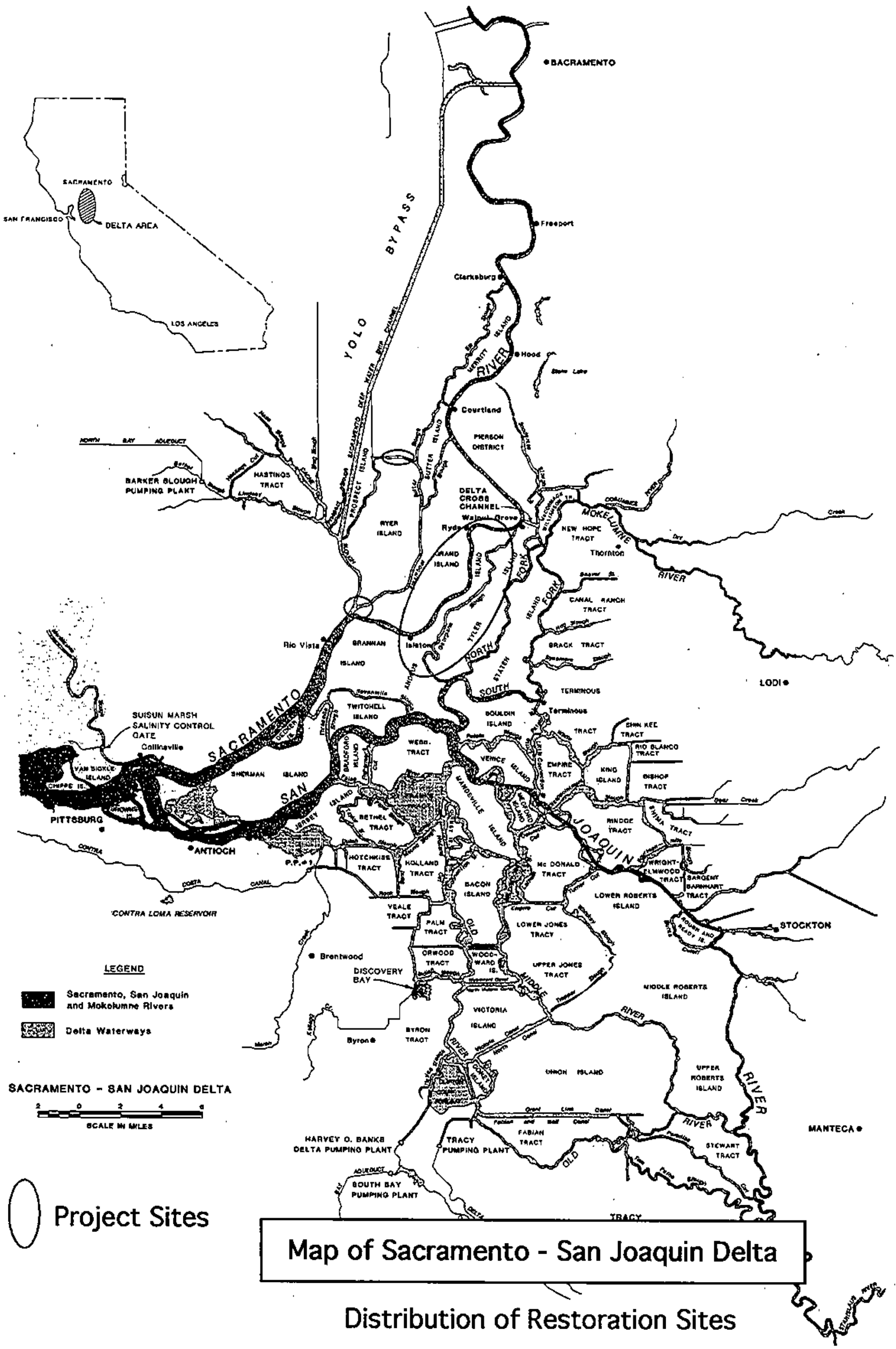
J. Threshold Requirements

1. Proposal Cover Sheet (on cover of proposal)
2. Environmental Compliance Checklist
3. Land Use Checklist
4. Local Notification Letters
5. State and Federal Contract Forms

Table 1. Restoration of Delta Floodplain Terraces Through Bioengineering

Year	Task	Direct Labor Hours	Salary	Benefits	Travel	Supplies & Expendables	Service Contracts	Overhead (show %)	Equipment	Total Cost
			Subject to Overhead						Exempt f/oh	
Year 1	Task 1									$0
	Subtask 1. Planning/Permitting		$10,000				$15,000			$25,000
	Subtask 2. Restoration/Monitoring Plan		$25,000				$10,000			$35,000
	Subtask 3. Plant Propagation		$25,000							$25,000
	Subtask 4. Materials					$30,000			$20,000	$50,000
	Subtask 5. Restoration implementation		$180,000							$180,000
	Subtask 6. Monitoring		$20,000			$40,000				$60,000
	Subtask 7. Project Management		$50,000							$50,000
Total Cost Year 1			$310,000	$0	$0	$70,000	$25,000	$0	$20,000	$425,000
Year 2	Task 2									$0
	Subtask 1. Planning/Permitting		$5,000				$5,000			$10,000
	Subtask 2. Restoration/Monitoring Plan		$5,000							$5,000
	Subtask 3. Plant Propagation		$40,000							$40,000
	Subtask 4. Materials/Equipment					$50,000			$20,000	$70,000
	Subtask 5. Restoration implementation		$200,000				$50,000			$250,000
	Subtask 6. Monitoring		$40,000				$25,000			$65,000
	Subtask 7. Project Management		$50,000							$50,000
Total Cost Year 2			$340,000	$0	$0	$50,000	$80,000	$0	$20,000	$490,000
Year 3	Task 3									
	Subtask 1. Planning/Permitting									$0
	Subtask 2. Restoration/Monitoring Plan		$5,000							$5,000
	Subtask 3. Plant Propagation		$10,000							$10,000
	Subtask 4. Materials/Equipment						$40,000		$10,000	$50,000
	Subtask 5. Restoration implementation		$90,000				$10,000			$100,000
	Subtask 6. Monitoring		$50,000				$20,000			$70,000
	Subtask 7. Project Management		$50,000							$50,000
Total Cost Year 3			$205,000			$0	$70,000		$10,000	$285,000
Total Project Cost			$855,000	$0	$0	$120,000	$175,000	$0	$50,000	$1,200,000

Restoration of Delta Floodplain Terraces Through Bioengineering

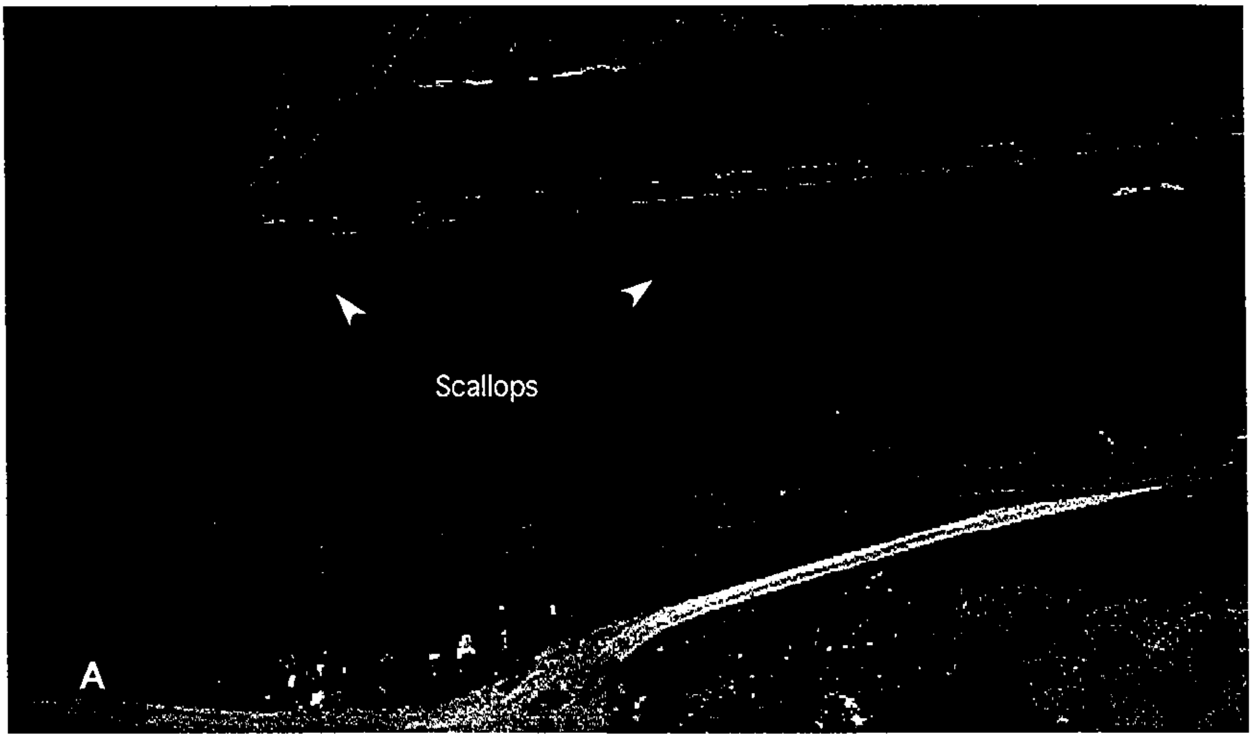


Map of Sacramento - San Joaquin Delta

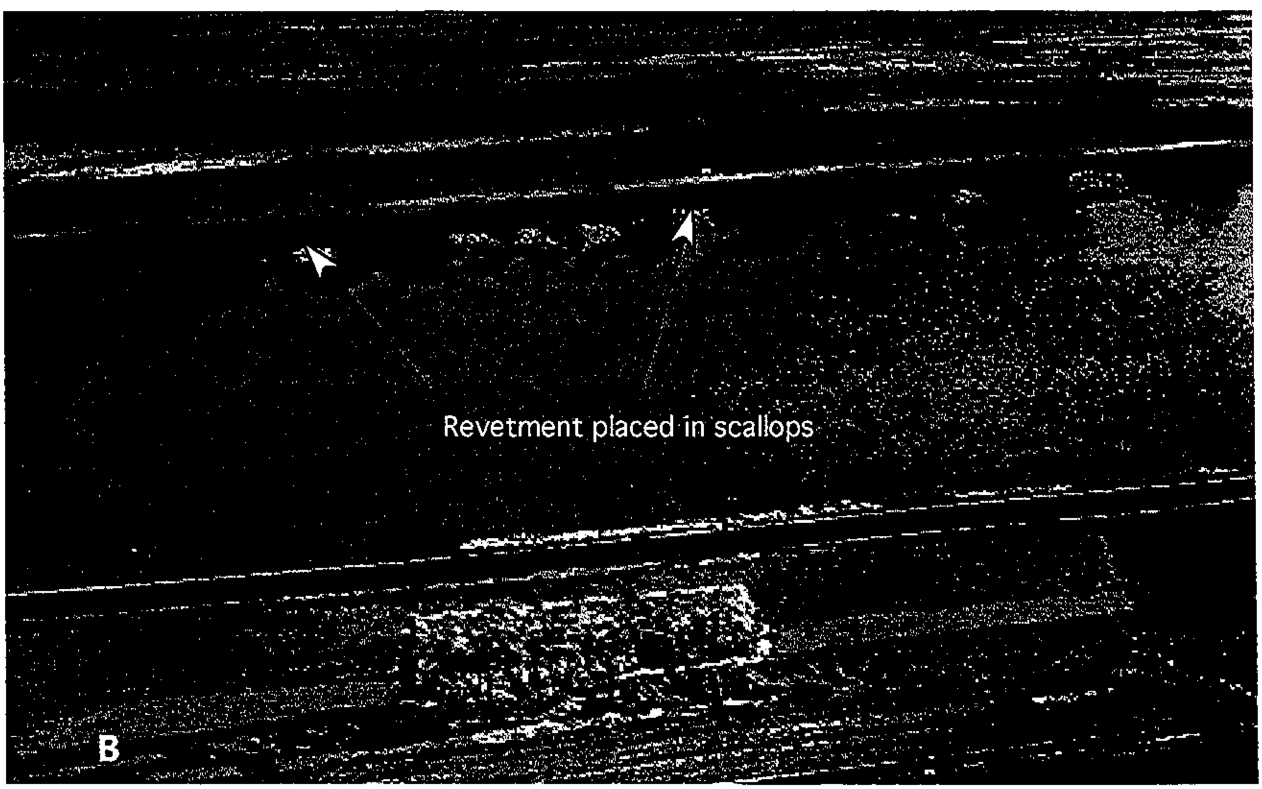
Distribution of Restoration Sites

Figure 1

HART



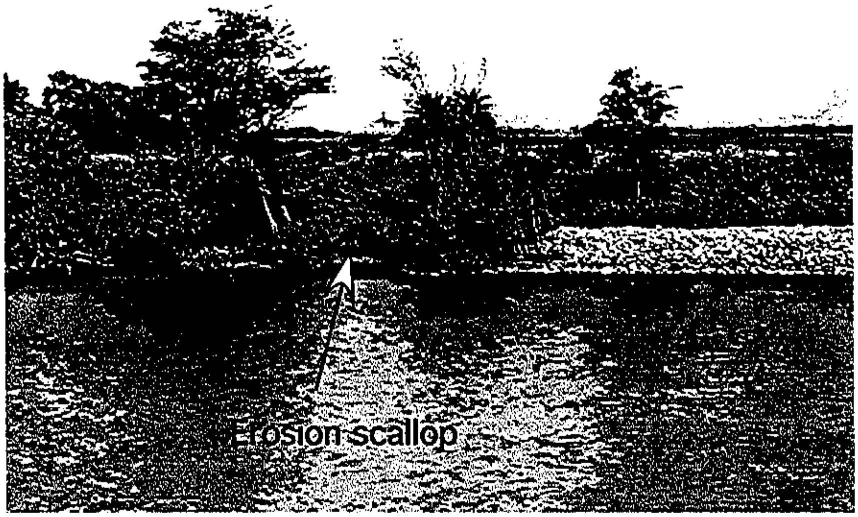
Note eroded semicircular scallops along bank of Georgiana Slough.



Placement of riprap in the scallops when erosion comes close to the levee toe.

Aerial Photograph of Erosion Scallops and Riprap Placement
on Georgiana Slough

Figure 2



Bank Erosion

Above: Bank erosion, leading to scallop formation, on the Sacramento River on upper Andrus Island. Note the placement of riprap on right. Below: Bank erosion on Grand Island. Toe of levee is being undercut by current and wave action.

Figure 3

Erosion

1. Wave-Energy Dissipation
   Problem: Boat wakes, especially during the summer months, cause erosion along the embankment.
   Solution: Structures outboard of the eroding banks need to be installed that break the waves and dissipate their energy. Recommended structures include floating log breakwater structures, fabric-encapsulated straw bales and brush bundles, and brush boxes.

2. Sediment Capture
   Problem: Considerable sediment passes through the Delta, especially during the winter months. Sediment is needed to build and maintain embankments.
   Solution: Sediment-capturing structures, such as brush fences, dense plantings, and coir biologs, will be placed in the waterways adjacent to the bank to induce accretion of fine materials.

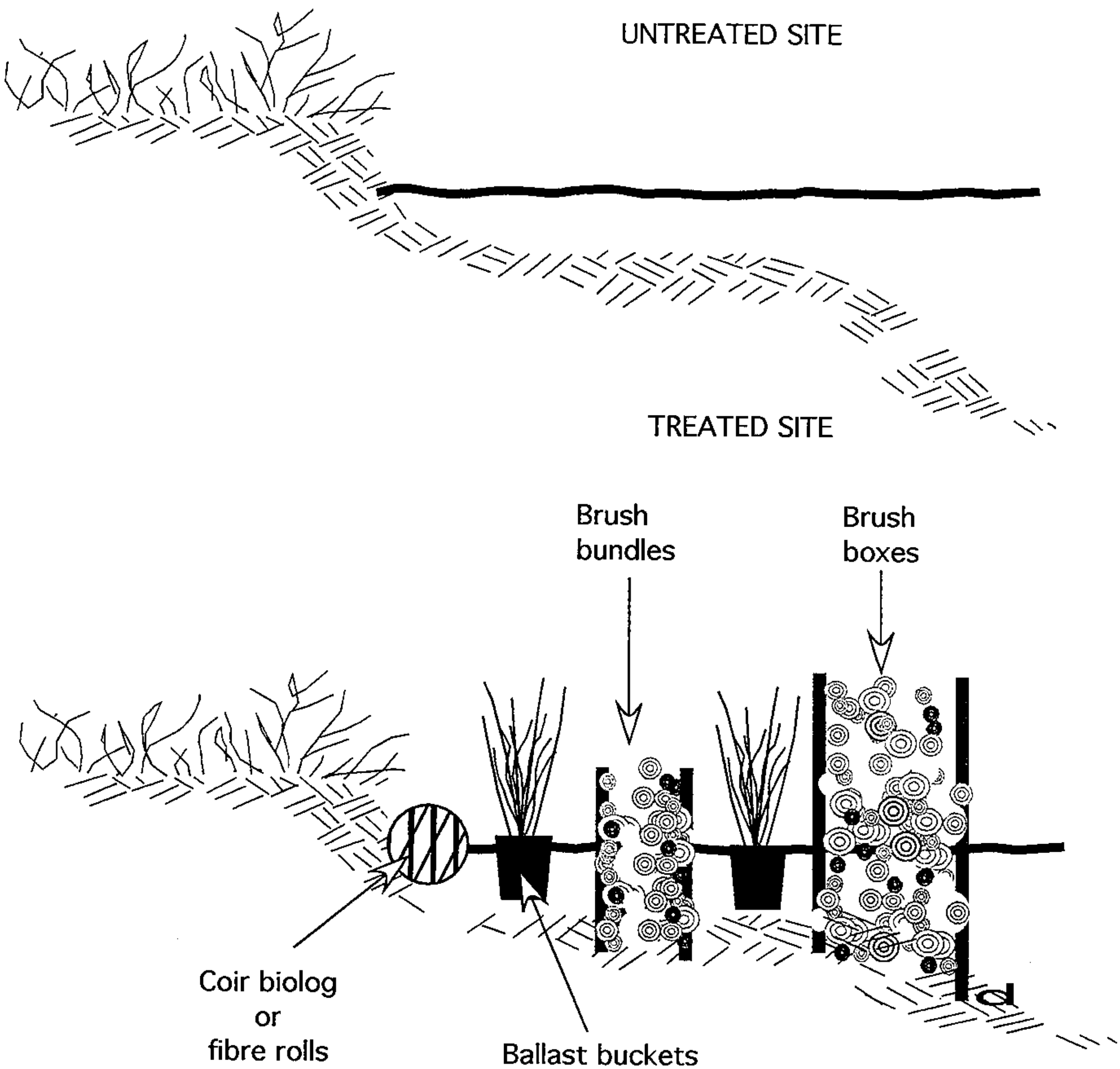
3. Ballast Plantings
   Problem: Erosive action of flowing water and boat wakes can erode habitat and vegetation plantings.
   Solution: In addition to the wave-attenuation structures, specialized ballast-bucket planting techniques will be applied.

Alternative Bank-Protection Strategies

Figure 4

Restoration of Delta Floodplain Terraces Through Bioengineering

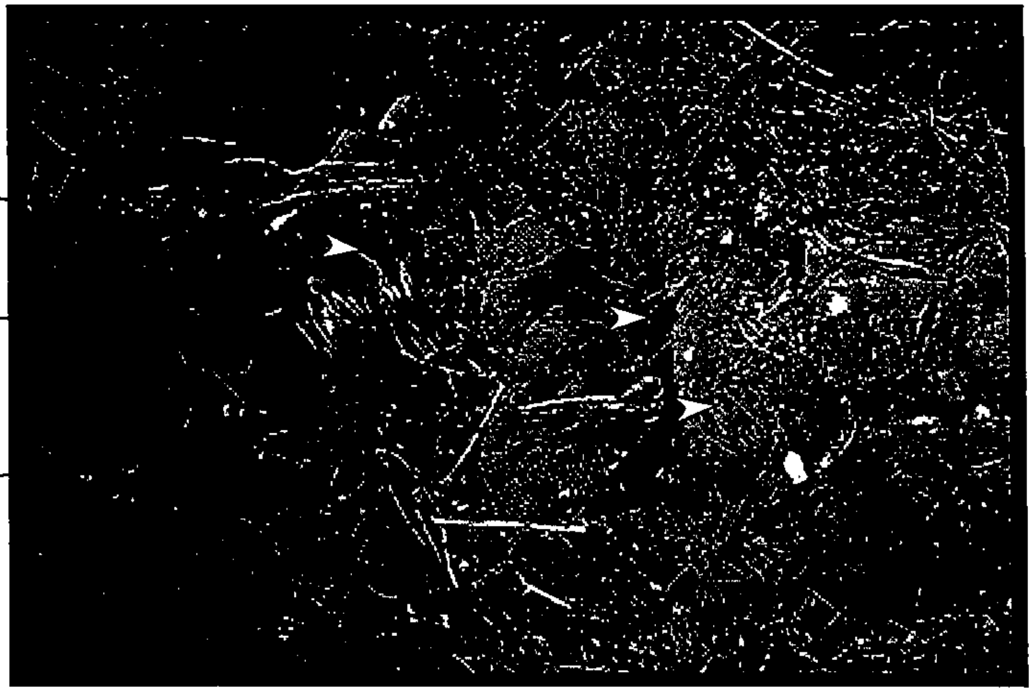
Design for low bank, moderate slope



Composite Brush Works/Ballast Buckets

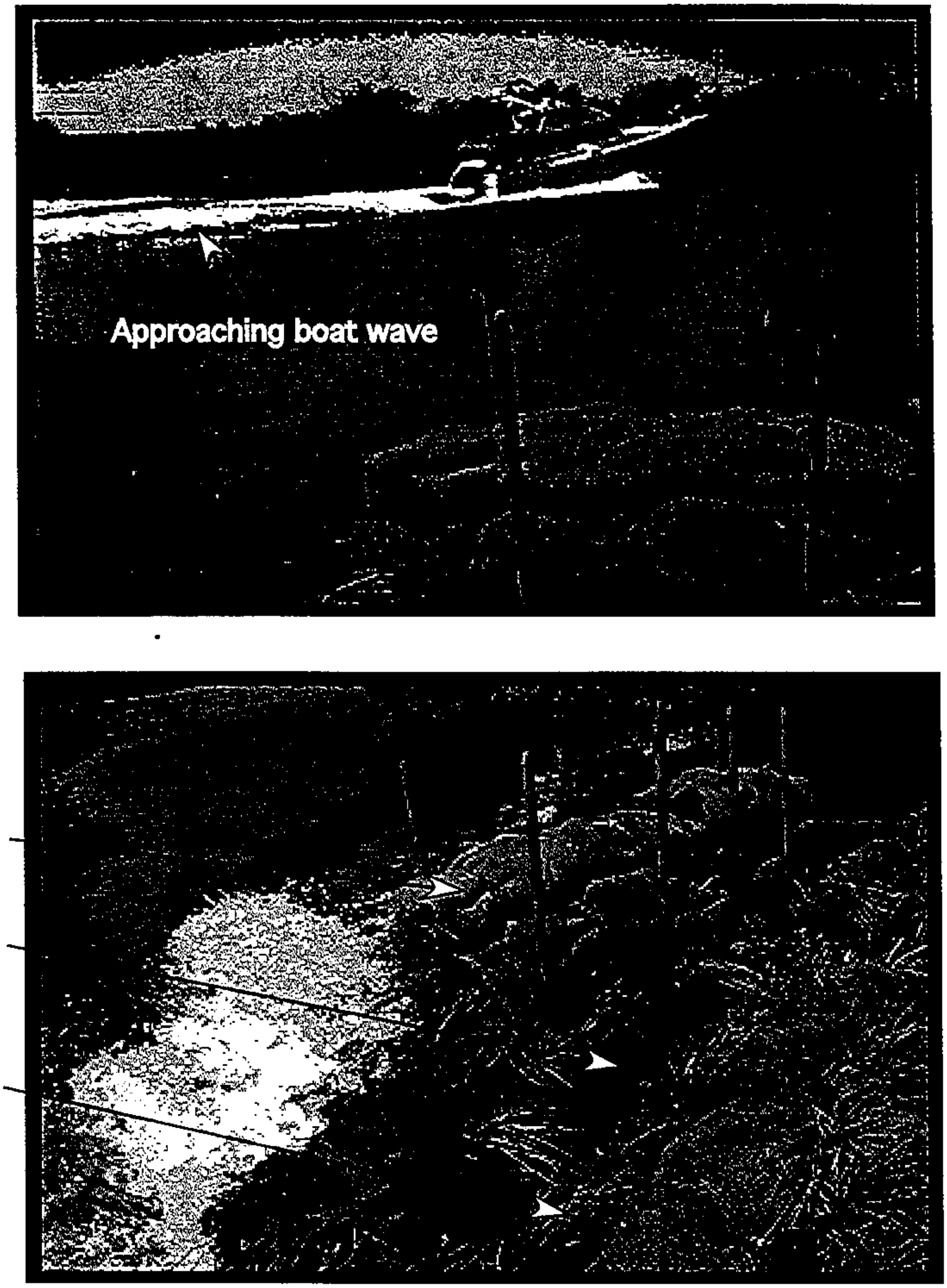
Composite protection and habitat enhancement techniques include brush boxes to serve as breakwaters, coir-wrapped brush bundles and coir biologs to capture sediment, and ballast-bucket plantings for habitat establishment.

Figure 5



Sample Restoration Site on Georgiana Slough

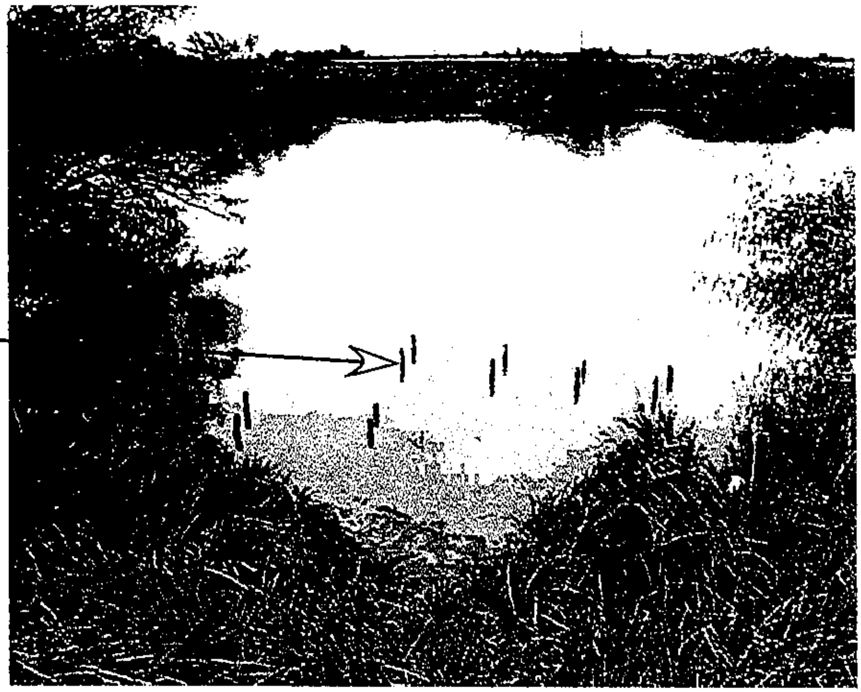
Above: Scallop no. 4A before construction in spring 1999. Below: Same site after construction in fall 1999. More than 33 sites, totalling approximately 1,880 feet, were installed in the first field season.

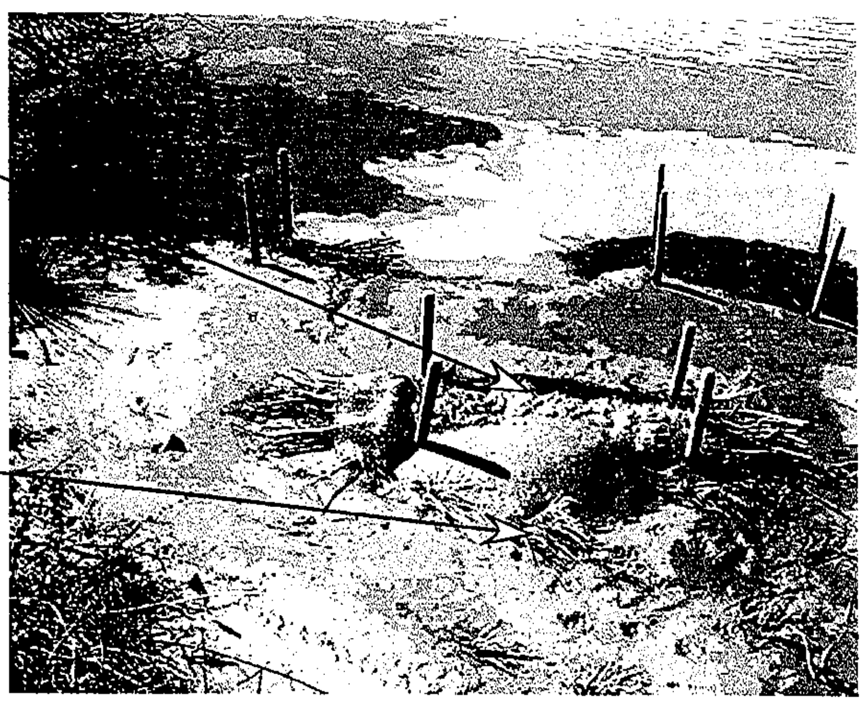


Effect of Brush Works in Dampening Boat Wave Energy

Above: Boat waves approaching brush works. Below: Beneficial effect of brush works in deflecting boat waves; note that waves do not penetrate beyond brush boxes.

Figure 7





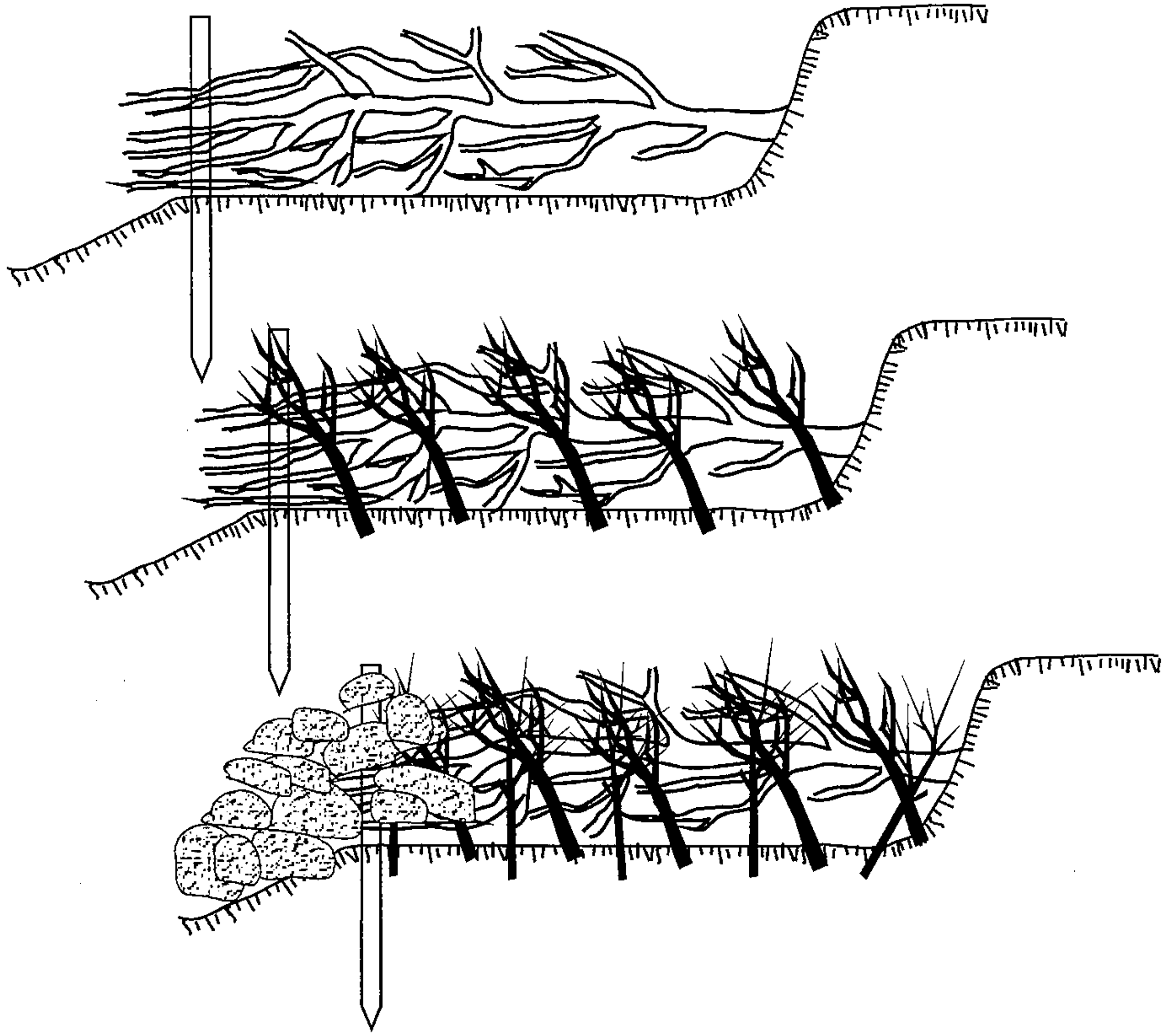
Effect of Brush Works in Precipitating Sediment Deposition during Winter 2000 Flooding

Above: Winter flooding, with presumed deposition occurring. Below: After winter flooding. Note ample amounts of deposition (approximately 2 feet).

Figure 8

Restoration of Delta Floodplain Terraces Through Bioengineering

Design for low bank, moderate slope.



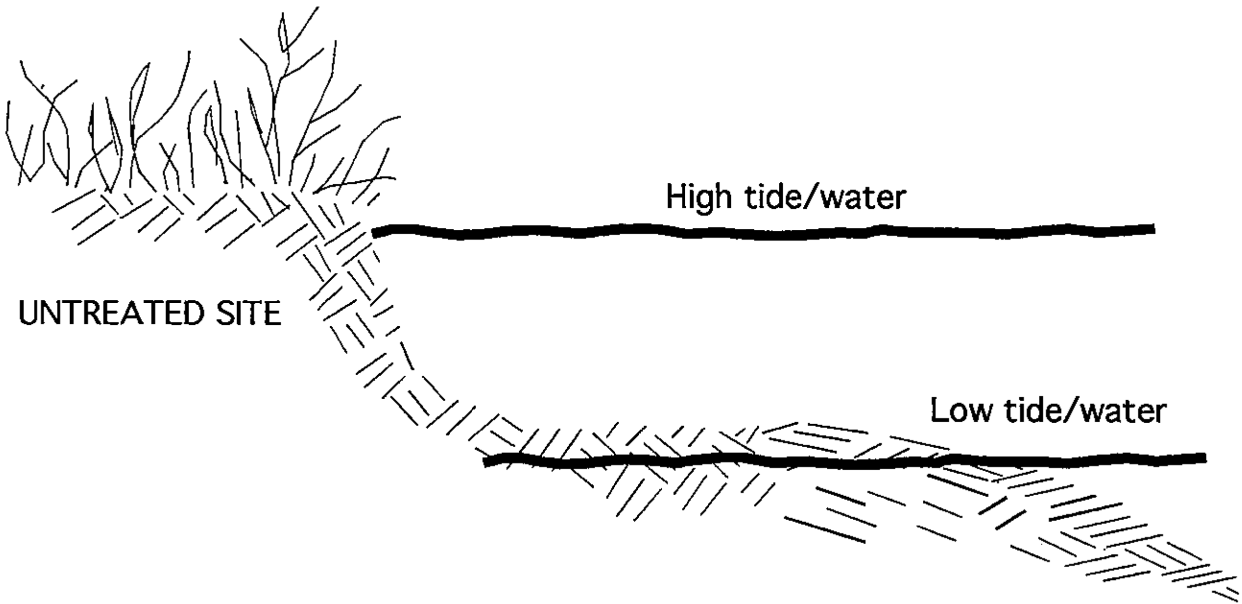
Log Brush Barriers

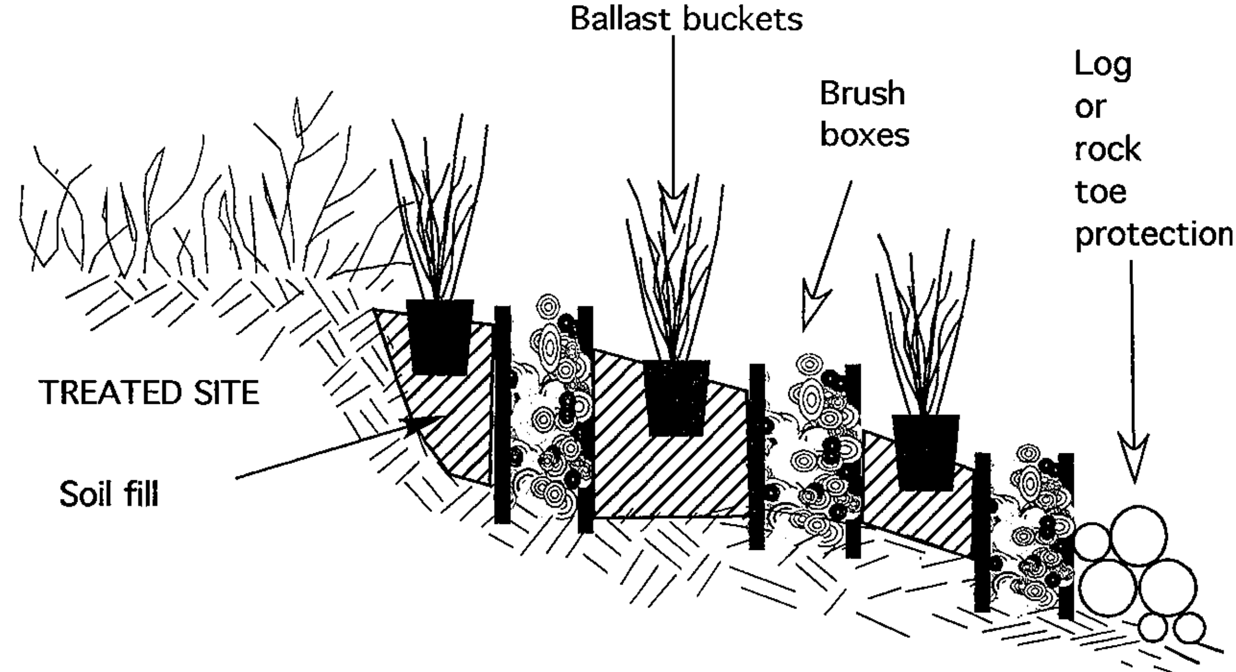
1. A row of stakes or posts are driven into the ground along the shoreline. Tree branches and trunks are placed at right angles to the shoreline, with the butt ends extending into the eroded bank. 2. Branches are stuck into the bank bottom between the existing branches, forming a dense cover. 3. A final layer of branches is placed at right angles to the first set of branches. 4. Twine or rope may be used to tie down the entire set of branches. 5. Rocks may be placed on top of and/or on the outside of the structure for additional support. Redrawn from Schiechtl, Bioengineering for Land Reclamation and Conservation.

Figure 9

Restoration of Delta Floodplain Terraces Through Bioengineering

Design for moderate bank and slope





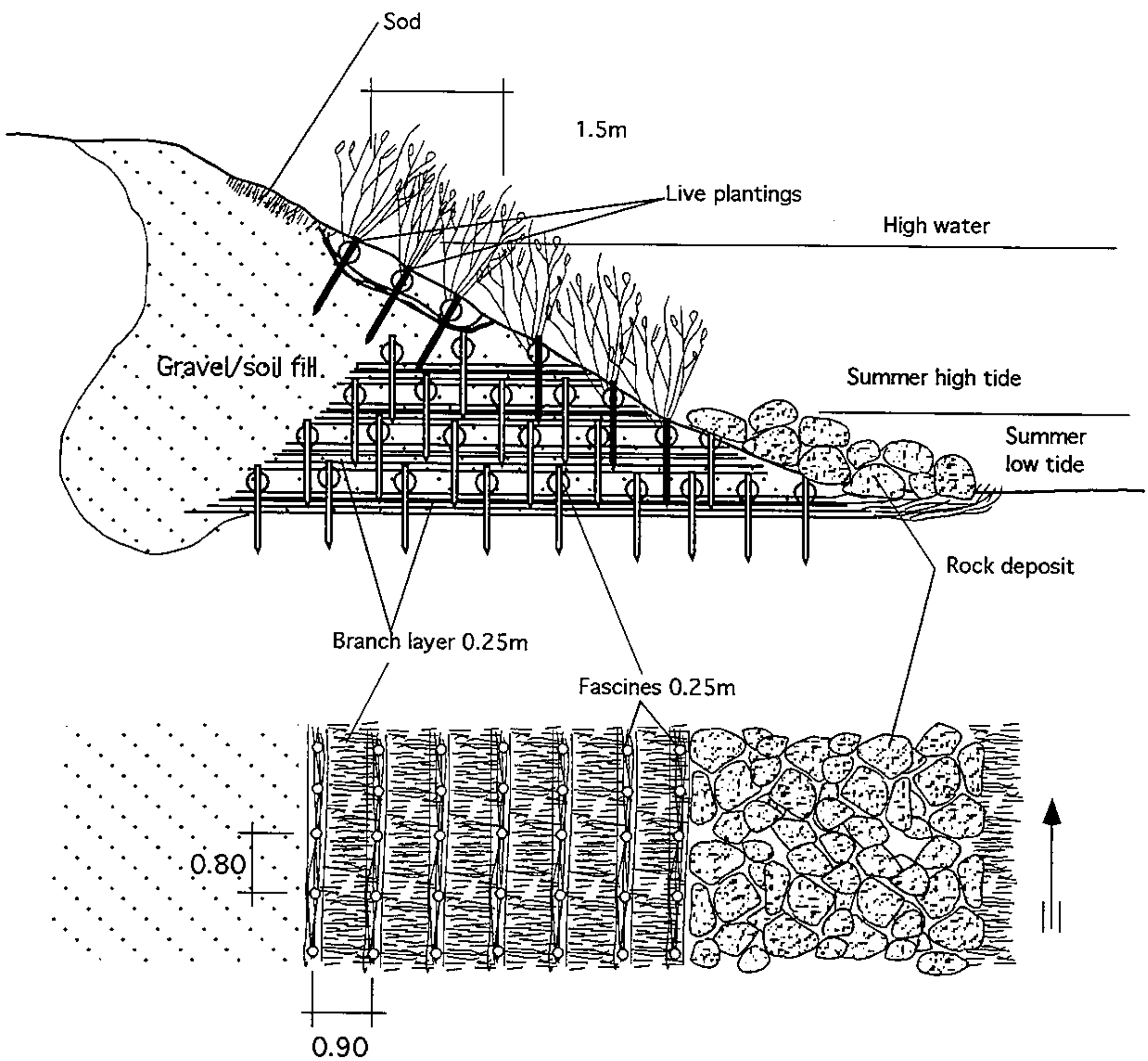
Earth-Filled Composite Brush Works

This treatment differs from a previous one in that soil fill is added to the site. The design takes into consideration higher bank profiles and the lower probability of natural sediment recruitment.

Figure 10

Restoration of Delta Floodplain Terraces Through Bioengineering

Design for moderate bank height and moderate slope



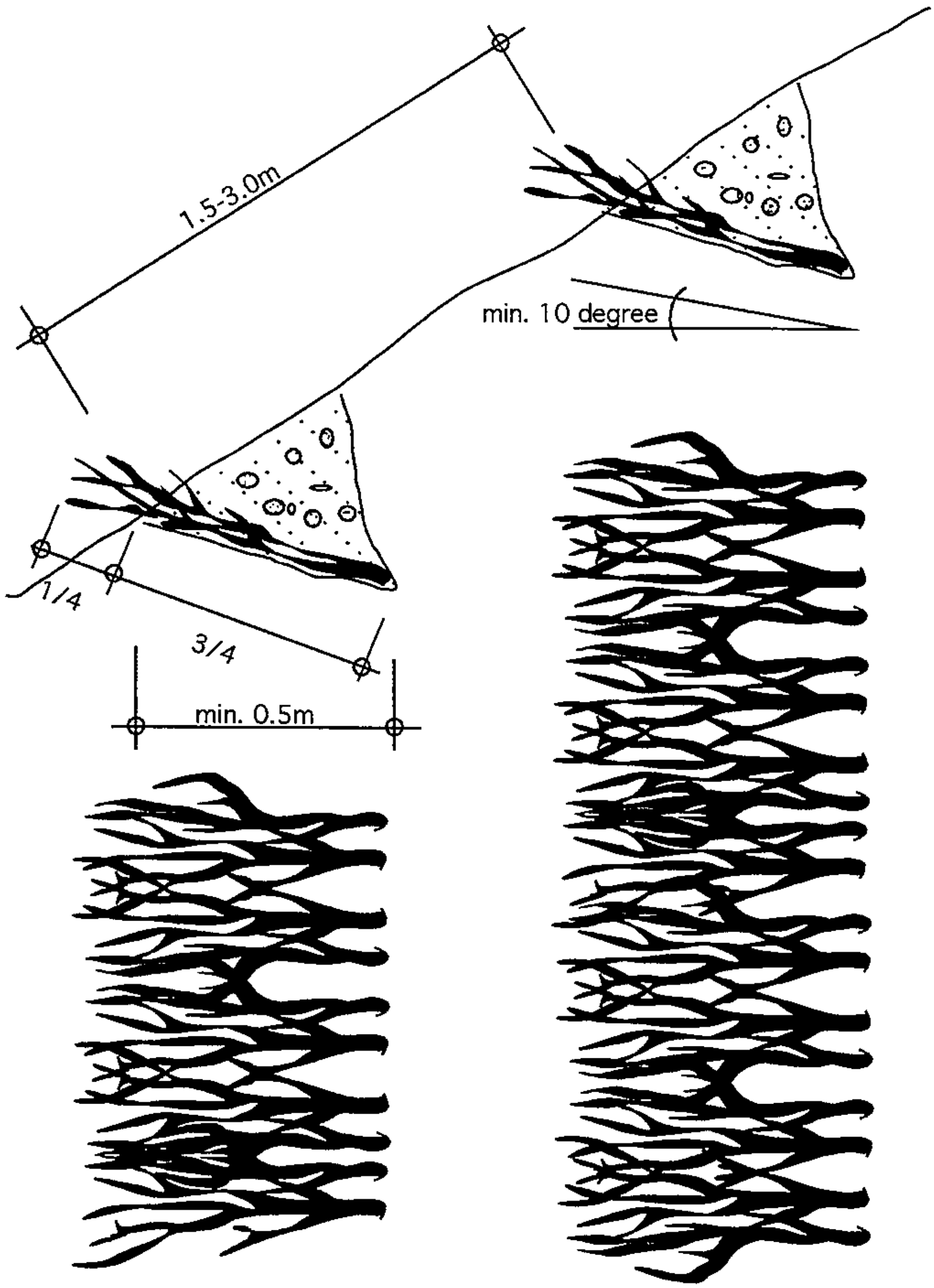
Branching Packing for Shore Protection

Branch layers and gravel and rocks are laid down in alternate layers. Each layer is secured with stakes and twine. Rock is used for toe protection. Plants are installed above the rockworks. Redrawn from Schiechtl, Bioengineering for Land Reclamation and Conservation.

Figure 11

Restoration of Delta Floodplain Terraces Through Bioengineering

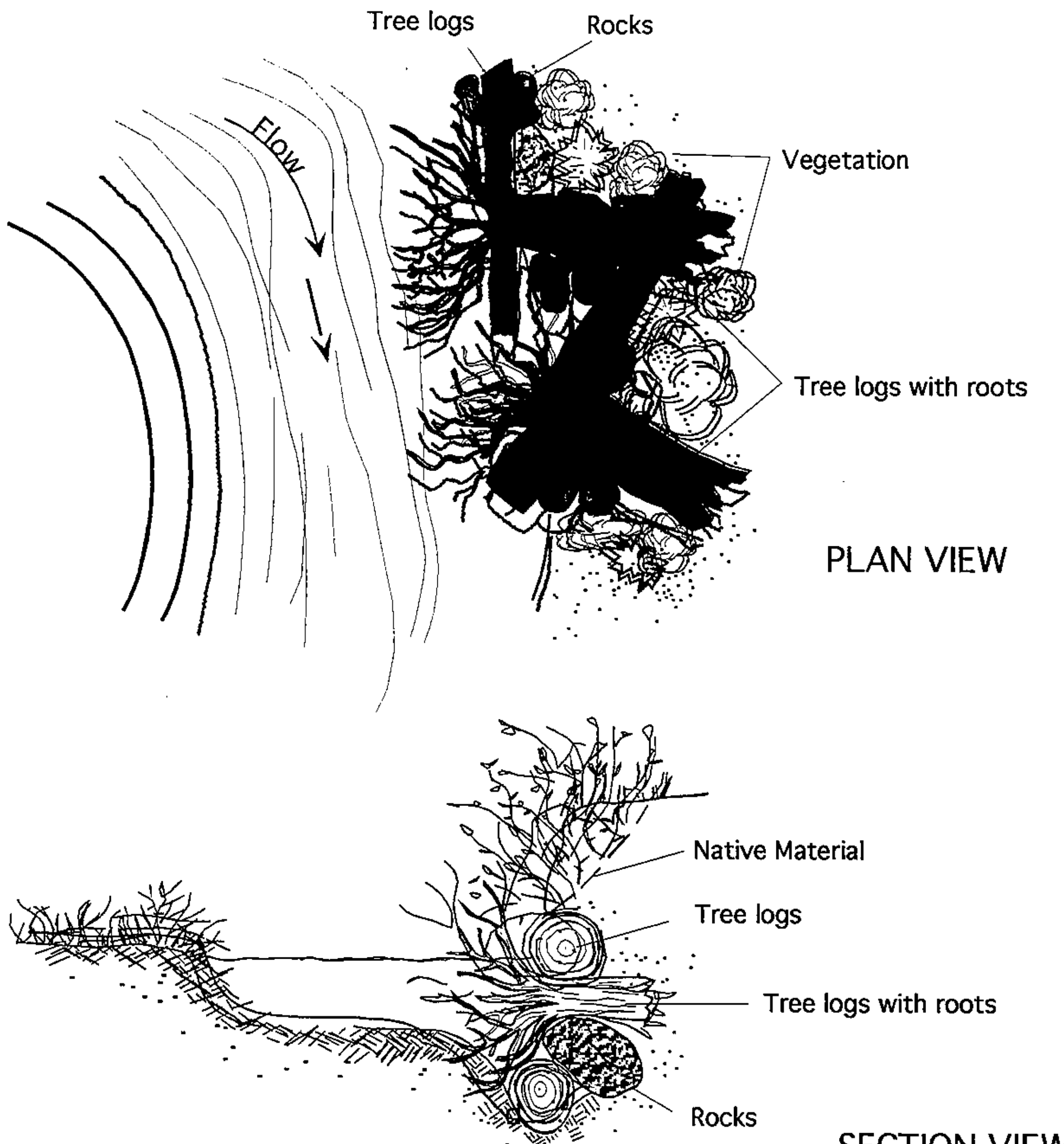
Design for moderate bank height and slope



Brushlayer

1. Dig out terrace along slope, with the platform angling about 10% upward. 2. Lay live branches, measuring 3-4 feet long each, in terrace. 3. Place soil in ditch, using soil dug out from above terrace. 4. Site can be planted later. Redrawn from Schiechtl, Bioengineering for Land Reclamation and Conservation.

Design for moderate bank height and moderate slope



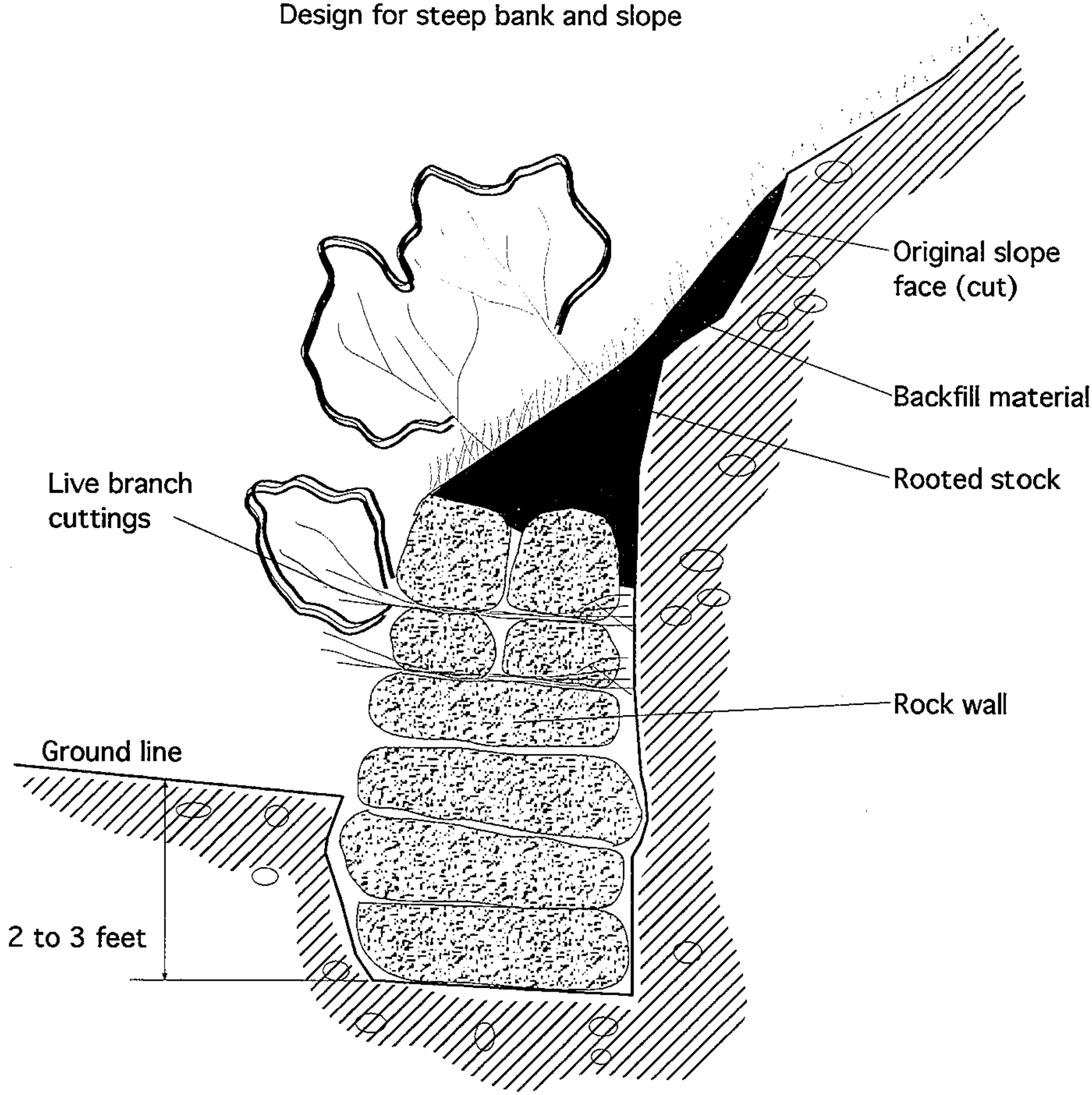
Rootwad Construction

Rootwad construction consists of placing the trunk base/root section of trees along the lower portions of banks, with the roots directed toward the river flow. Logs and rocks are placed around the rootwad for additional protection.

Figure 13

Restoration of Delta Floodplain Terraces Through Bioengineering

Design for steep bank and slope

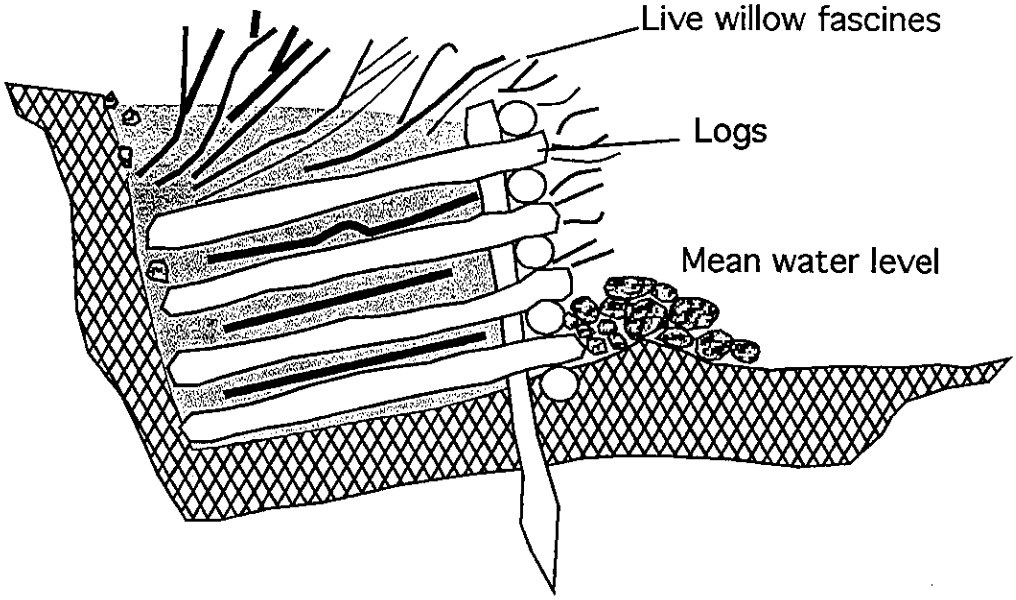


Vegetated Rock Walls

Place rocks at the lowest point of the slope, forming a stable base. Live branch cuttings can be inserted between the rocks, making contact with soil behind the rocks. Alternatively, container plants with well protected roots can be placed between rocks during installation. Place backfill soil above rocks. Adapted from Gray and Sotir, Biotechnical and Soil Bioengineering Slope Stabilization.

Restoration of Delta Floodplain Terraces Through Bioengineering

Design for steep bank and slope

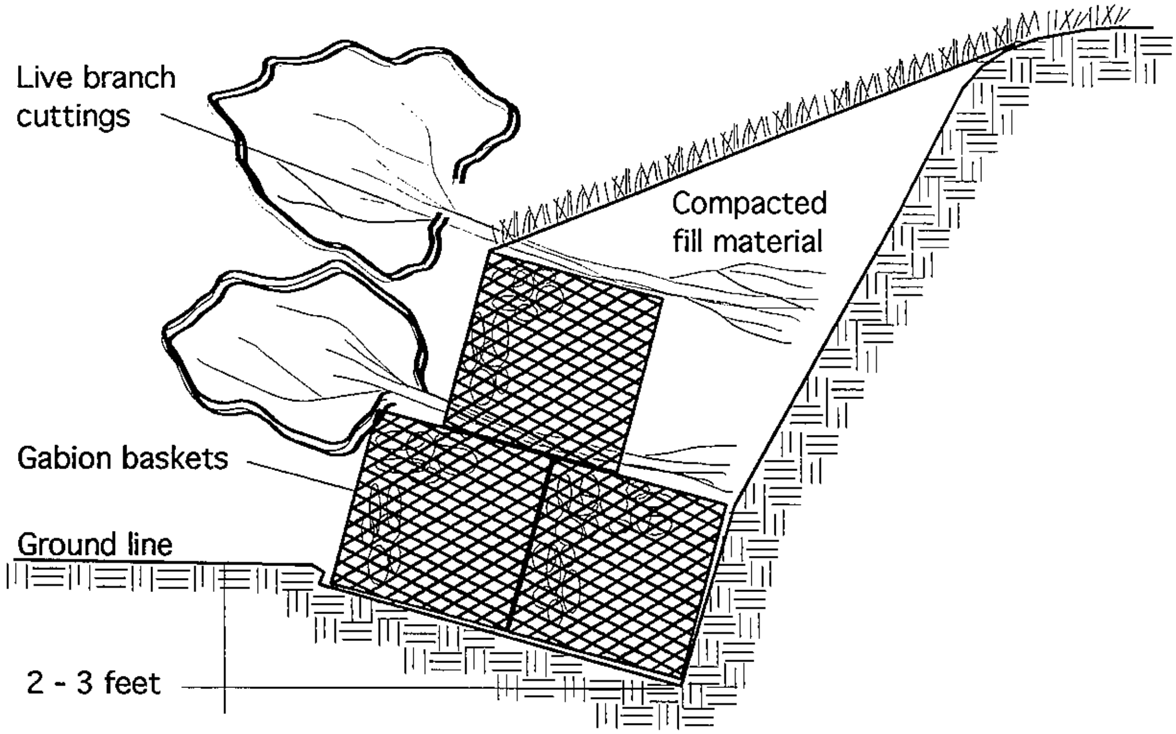


Wood Crib Wall

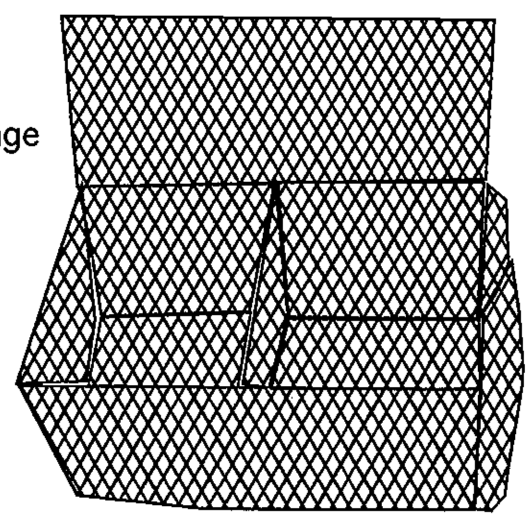
A crib wall is made up of a box-like arrangement of logs or beams, filled with appropriate backfill material, in which live willow cuttings are inserted. Crib walls are useful at the base of slopes to reduce the steepness of a slope and to protect the base from scour and undermining. The site is excavated 2-3 feet below the ground surface (at low tide), where a stable foundation is created. The footing base should be inclined into the slope to enhance stability. The first logs are placed at the front and the back of the excavation, the second set of logs are placed at right angles, and so forth. Live cuttings or containerized plants can be inserted between the logs. After each layer of branches, add compacted soil.

Restoration of Delta Floodplain Terraces Through Bioengineering

Design for steep bank and slope



Typical wire gabion cage



Gabion Wire Baskets

Gabions are rectangular containers made from galvanized steel wire. Before placement, the base of an embankment is dug out, with the terrace at a slight angle toward the bank. Gabion baskets are filled with rock or stone and staked on top of one another along the steep embankment. Live branch cuttings may be placed between the gabions, with dirt fill placed between the top row of gabions and the bank.

Figure 16

Environmental Compliance Checklist

All applicants must fill out this Environmental Compliance Checklist. Applications must contain answers to the following questions to be responsive and to be considered for funding. *Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered for funding.*

1. **Do any of the actions included in the proposal require compliance with either the California Environmental Quality Act (CEQA), the National Environmental Policy Act (NEPA), or both?**

✓ **YES** ____ **NO**

2. **If you answered yes to # 1, identify the lead governmental agency for CEQA/NEPA compliance.**

CEQA: Reclamation Districts 563, 556, 3, 999, Brannan - Andrus Levee Maintenance District

Lead Agency

NEPA: thru Nationwide 13, U.S. Army Corps of Engineers

3. **If you answered no to # 1, explain why CEQA/NEPA compliance is not required for the actions in the proposal.**

4. **If CEQA/NEPA compliance is required, describe how the project will comply with either or both of these laws. Describe where the project is in the compliance process and the expected date of completion.**

We anticipate a categorical exemption under CEQA. There are 29 classes of categorical exemptions. The proposed projects fall into Class 2: Replacement or Reconstruction of Existing Structures or Facilities. We are replacing the berm which will have the same purpose & capacity as the original.

5. **Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?**

✓ **YES** ____ **NO**

If yes, the applicant must attach written permission for access from the relevant property owner(s). Failure to include written permission for access may result in disqualification of the proposal during the review process. Research and monitoring field projects for which specific field locations have not been identified will be required to provide access needs and permission for access with 30 days of notification of approval.

We already have permission from Reclamation Districts 563, 556 and Brannan - Andrus Levee Maintenance District (from previous work). Reclamation Districts 999 and 3 have verbally agreed to this project.

6. **Please indicate what permits or other approvals may be required for the activities contained in your proposal. Check all boxes that apply.**

<u>LOCAL</u>		
Conditional use permit	___	
Variance	___	
Subdivision Map Act approval	___	
Grading permit	___	
General plan amendment	___	
Specific plan approval	___	
Rezone		___
Williamson Act Contract cancellation	___	
Other ________________ (please specify)		
None required	___	
<u>STATE</u>		
CESA Compliance	___	**(CDFG)**
Streambed alteration permit	✓	**(CDFG)**
CWA § 401 certification	✓	**(RWQCB)**
Coastal development permit	___	**(Coastal Commission/BCDC)**
Reclamation Board approval	✓	
Notification	___	**(DPC, BCDC)**
Other ________________ (please specify)		
None required	___	
<u>FEDERAL</u>		
ESA Consultation	✓	**(USFWS)**
Rivers & Harbors Act permit	___	**(ACOE)**
CWA § 404 permit	✓	**(ACOE)**
Other ________________ (please specify)		
None required	___	

DPC = Delta Protection Commission
CWA = Clean Water Act
CESA = California Endangered Species Act
USFWS = U.S. Fish and Wildlife Service
ACOE = U.S. Army Corps of Engineers

ESA = Endangered Species Act
CDFG = California Department of Fish and Game
RWQCB = Regional Water Quality Control Board
BCDC= Bay Conservation and Development Comm.

Land Use Checklist

All applicants must fill out this Land Use Checklist for their proposal. Applications must contain answers to the following questions to be responsive and to be considered for funding. *Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered for funding.*

1. **Do the actions in the proposal involve physical changes to the land(i.e. grading, planting vegetation, or breeching levees) or restrictions in land use (i.e. conservation easement or placement of land in a wildlife refuge)?**

   ✓ YES — Involves planting only, minor maintenance.

   ____ NO

2. **If NO to # 1, explain what type of actions are involved in the proposal (i.e., research only, planning only).**

3. **If YES to # 1, what is the proposed land use change or restriction under the proposal?**

4. **If YES to # 1, is the land currently under a Williamson Act contract?**

   ____ YES

   ✓ NO

5. **If YES to # 1, answer the following:**

   Current land use ____________
   Current zoning ____________
   Current general plan designation ____________

6. **If YES to #1, is the land classified as Prime Farmland, Farmland of Statewide Importance or Unique Farmland on the Department of Conservation Important Farmland Maps?**

   ____ YES

   ✓ NO

   ____ DON'T KNOW

7. **If YES to # 1, how many acres of land will be subject to physical change or land use restrictions under the proposal?**

   4-5 acres of riverfront

8. **If YES to # 1, is the property currently being commercially farmed or grazed?**

   ____ YES

   ✓ NO

9. **If YES to #8, what are**

   the number of employees/acre none
   the total number of employees none

10. **Will the applicant acquire any interest in land under the proposal (fee title or a conservation easement)?**

_______ **YES** ✓ **NO**

11. **What entity/organization will hold the interest?** Reclamation Districts

12. **If YES to # 10, answer the following:**

Total number of acres to be acquired under proposal	none
Number of acres to be acquired in fee	none
Number of acres to be subject to conservation easement	none

13. **For all proposals involving physical changes to the land or restriction in land use, describe what entity or organization will:**

manage the property	Reclamation districts
provide operations and maintenance services	" "
conduct monitoring	?

14. **For land acquisitions (fee title or easements), will existing water rights also be acquired?**

_______ **YES** N.A. _______ **NO**

15. **Does the applicant propose any modifications to the water right or change in the delivery of the water?**

_______ **YES** ✓ **NO**

16. **If YES to # 15, describe**_______________________________

STATE OF CALIFORNIA

NONDISCRIMINATION COMPLIANCE STATEMENT

STD. 19 (REV. 3-95)

COMPANY NAME Habitat Assessment & Restoration Team, Inc.

The company named above (herinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, physical disability (including HIV and AIDS), medical condition (cancer), age (over 40), marital status, denial of family care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME Jeffrey A. Hart
Jeffrey A. Hart

DATE EXECUTED 5/16/00

EXECUTED IN THE COUNTY OF

PROSPECTIVE CONTRACTOR'S SIGNATURE Jeffrey A. Hart

PROSPECTIVE CONTRACTOR'S TITLE President

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME Habitat Assessment & Restoration Team, Inc.

DCC ENGINEERING CO., INC.

ARCHITECTURE
CIVIL ENGINEERING
LAND USE PLANNING
ENVIRONMENTAL / PERMITTING
PROJECT CONSTRUCTION MANAGEMENT

May 10, 2000

Jeffrey A. Hart, Ph.D.
Habitat Assessment and Restoration Team, Inc.
13737 Grand Island Road
Walnut Grove, CA 95690

RE: Sacramento River Habitat Project - Restoration of Delta Terraces through Bio-engineering

Dear Mr. Hart:

Brannan-Andrus Levee Maintenance District is pleased to again be offered the opportunity to participate in a habitat restoration project being proposed for CALFED funding support. The District would like to re-affirm its support for the use of Sacramento River levee reaches, within its area of jurisdiction, as demonstration sites for your project. The Sacramento River is a good candidate for your habitat restoration efforts because the vegetated berms, that evolved after the levees were set back in the early 50's, have been eroding at an alarming pace resulting in the loss of some critical habitat and the exposure of the principal levee section. The scalloped low-tide benches created by that erosion process should lend themselves to habitat restoration strategies that provide erosion protection and encourage silt deposition.

The District is prepared to contribute to your effort and would like to work closely with you as your project moves into the final design and implementation stages, to insure that the finished project has the potential to provide mutually beneficial results.

Again, thank you for this opportunity.

Sincerely,

Gilbert Labrie

DCC Engineering, District Engineer
Gilbert Labrie, Managing Principal

Cc: BALMD Directors

H.A.R.T. Inc.
Habitat Assessment
& Restoration Team

May 12, 2000

Sacramento County Planning Department
827 7th Street
Sacramento, CA 95814

To Whom It May Concern:

This is to notify you that the Habitat Assessment & Restoration Team, Inc. is submitting a CALFED proposal for funds to enhance habitat and provide levee protection along Georgiana Slough, Sacramento River, Steamboat Slough, and Miner Slough, located immediately south, southwest, and northwest of Walnut Grove, in Sacramento County. I am sending you a copy of the executive summary that will acquaint you with our proposed project. Let me know if you would like to receive a copy of the entire proposal.

Sincerely,

Jeffrey A. Hart

Jeffrey A. Hart

13737 Grand Island Road
Walnut Grove, CA 95690
phone: 916/775-4021
fax: 916/775-4022

H.A.R.T. Inc.
Habitat Assessment
& Restoration Team

May 12, 2000

Delta Protection Commission
14215 River Road
P.O. Box 530
Walnut Grove, CA 95690

To Whom It May Concern:

This is to notify you that the Habitat Assessment & Restoration Team, Inc. is submitting a CALFED proposal for funds to enhance habitat and provide levee protection along Georgiana Slough, Sacramento River, Steamboat Slough, and Miner Slough, located immediately south, southwest, and northwest of Walnut Grove, in Sacramento County. I am sending you a copy of the executive summary that will acquaint you with our proposed project. Please let me know if you would like to receive the entire proposal.

Sincerely,

Jeffrey A. Hart

Jeffrey A. Hart

13737 Grand Island Road
Walnut Grove, CA 95690
phone: 916/775-4021
fax: 916/775-4022

DCC ENGINEERING CO.,INC.

ARCHITECTURE
CIVIL ENGINEERING
LAND USE PLANNING
ENVIRONMENTAL / PERMITTING
PROJECT CONSTRUCTION MANAGEMENT

May 10, 2000

Jeffrey A. Hart, Ph.D.
Habitat Assessment and Restoration Team, Inc.
13737 Grand Island Road
Walnut Grove, CA 95690

RE: Sacramento River Habitat Project - Restoration of Delta Terraces through Bio-engineering

Dear Mr. Hart:

Brannan-Andrus Levee Maintenance District is pleased to again be offered the opportunity to participate in a habitat restoration project being proposed for CALFED funding support. The District would like to re-affirm its support for the use of Sacramento River levee reaches, within its area of jurisdiction, as demonstration sites for your project. The Sacramento River is a good candidate for your habitat restoration efforts because the vegetated berms, that evolved after the levees were set back in the early 50's, have been eroding at an alarming pace resulting in the loss of some critical habitat and the exposure of the principal levee section. The scalloped low-tide benches created by that erosion process should lend themselves to habitat restoration strategies that provide erosion protection and encourage silt deposition.

The District is prepared to contribute to your effort and would like to work closely with you as your project moves into the final design and implementation stages, to insure that the finished project has the potential to provide mutually beneficial results.

Again, thank you for this opportunity.

Sincerely,

Gilbert Labrie

DCC Engineering, District Engineer
Gilbert Labrie, Managing Principal

Cc: BALMD Directors

POST OFFICE BOX 929 • WALNUT GROVE, CALIFORNIA 95690 • (916) 776-2277 • FAX (916) 776-2282

Reclamation District No. 3
GRAND ISLAND
P.O. Box 104
Ryde, California 95680

May 9, 2000

Jeff Hart, PhD.
Habitat Assessment and Restoration Team, Inc.
13737 Grand Island Road
Walnut Grove, California 95690

Subject: Biotechnical Erosion Repair

Dear Dr. Hart:

On behalf of Reclamation District No. 3, you are authorized to include several erosion sites on our levee along Steamboat Slough in your study regarding use of biotechnical erosion repair methods in the Sacramento/San Joaquin Delta. It is understood that any design must be approved by our Board of Trustees prior to construction. Our levee is also a component of the Sacramento River Flood Control Project, therefore, your work should also be coordinated with the State Reclamation Board.

Sincerely,
RECLAMATION DISTRICT NO. 3

BY: Ken Pucci, President

Reclamation District No. 999
38563 Netherlands Road
Clarksburg, California 95612

May 9, 2000

Jeff Hart, PhD.
Habitat Assessment and Restoration Team, Inc.
13737 Grand Island Road
Walnut Grove, California 95690

Subject: Biotechnical Erosion Repair

Dear Dr. Hart:

On behalf of Reclamation District No. 999, you are authorized to include several erosion sites on our levee along Miner Slough in your study regarding use of biotechnical erosion repair methods in the Sacramento/San Joaquin Delta. It is understood that any design must be approved by our Board of Trustees prior to construction. Our levee is also a component of the Sacramento River Flood Control Project, therefore, your work should also be coordinated with the State Reclamation Board.

Sincerely,
RECLAMATION DISTRICT NO. 999

Richard E. Marshall

BY: Richard Marshall, Manager

H.A.R.T. Inc.
Habitat Assessment & Restoration Team

May 10, 2000

Sacramento County Board of Supervisors
700 H. Street, Suite 304
Sacramento, CA 95814

To Whom It May Concern:

This is to notify the Sacramento County Board of Supervisors that the Habitat Assessment & Restoration Team, Inc. is submitting a CALFED proposal for funds to enhance habitat and provide levee protection along Georgiana Slough, Sacramento River, Steamboat Slough, and Miner Slough, located immediately south, southwest, and northwest of Walnut Grove, in Sacramento County. I am sending you a preliminary copy of the executive summary that will acquaint you with our proposed project.

Sincerely,

Jeffrey A. Hart

Jeffrey A. Hart

13737 Grand Island Road
Walnut Grove, CA 95690
phone: 916/775-4021
fax: 916/775-4022

APPLICATION FOR FEDERAL ASSISTANCE

OMB Approval No. 0348-0043

2. DATE SUBMITTED 5-30-00	Applicant Identifier
3. DATE RECEIVED BY STATE	State Application Identifier
4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier

1. TYPE OF SUBMISSION:

Application
- [x] Construction
- [ ] Non-Construction

Preapplication
- [ ] Construction
- [ ] Non-Construction

5. APPLICANT INFORMATION

Legal Name: Habitat Assessment and Restoration Team Inc

Organizational Unit:

Address *(give city, county, State, and zip code)*: 13737 Grand Island Road Walnut Grove, CA 95690

Name and telephone number of person to be contacted on matters involving this application *(give area code)* Jeff Hart (916) 775-4021

6. EMPLOYER IDENTIFICATION NUMBER *(EIN)*: 94-3274391

7. TYPE OF APPLICANT: *(enter appropriate letter in box)* M

A. State
B. County
C. Municipal
D. Township
E. Interstate
F. Intermunicipal
G. Special District
H. Independent School Dist.
I. State Controlled Institution of Higher Learning
J. Private University
K. Indian Tribe
L. Individual
M. Profit Organization
N. Other (Specify) ____________

8. TYPE OF APPLICATION:

- [x] New
- [ ] Continuation
- [ ] Revision

If Revision, enter appropriate letter(s) in box(es) [ ] [ ]

A. Increase Award B. Decrease Award C. Increase Duration
D. Decrease Duration Other *(specify)*:

9. NAME OF FEDERAL AGENCY:

10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: NA

TITLE:

11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT: Restoration of Delta Floodplain Terraces Through Bioengineering

12. AREAS AFFECTED BY PROJECT *(Cities, Counties, States, etc.)*: Sacramento County

13. PROPOSED PROJECT Floodplain Restoration

Start Date	Ending Date
Jan 2001	Jan. 2004

14. CONGRESSIONAL DISTRICTS OF: 11th District

a. Applicant Habitat Assessment & Restoration Team Inc.

b. Project Restoration of Delta Floodplain Terraces Through Bioengineering

15. ESTIMATED FUNDING:

a. Federal	$ .00
b. Applicant	$ .00
c. State	$ .00
d. Local	$ .00
e. Other	$ .00
f. Program Income	$ .00
g. TOTAL	$ 1,200,000 .00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS? N.A.

a. YES. THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:

DATE ____________

b. No.
- [ ] PROGRAM IS NOT COVERED BY E. O. 12372
- [ ] OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?

- [ ] Yes If "Yes," attach an explanation.
- [ ] No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT, THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Type Name of Authorized Representative	b. Title	c. Telephone Number
Jeffrey A. Hart President	President	(916) 775-4021

d. Signature of Authorized Representative Jeffrey A. Hart

e. Date Signed 5-30-00

Previous Edition Usable
Authorized for Local Reproduction

Standard Form 424 (Rev. 7-97)
Prescribed by OMB Circular A-102